SPECIFICATION NO. 118
AUGUST 17, 1962

AIRPLANE DETAIL SPECIFICATION

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LIFT FAN FLIGHT RESEARCH AIRCRAFT PROGRAM

[illegible] NUMBER DA[illegible]

GENERAL ELECTRIC

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LIFT FAN FLIGHT RESEARCH AIRCRAFT PROGRAM

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AIRPLANE DETAIL SPECIFICATION

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August 17, 1962

APPROVAL STATUS:

GENERAL ELECTRIC COMPANY
FLIGHT PROPULSION LABORATORY DEPARTMENT
CINCINNATI, OHIO

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LIST OF SYMBOLS

β_S	-	Fan Exit Louver Stagger Angle
βv	-	Fan Exit Louver Vector Angle
CG	-	Aircraft Center of Gravity
CPS	-	Cycles per Second
g	-	Acceleration due to Gravity
L/W	-	Lift Divided by Weight Ratio
RPM	-	Gas Generator Revolutions per Minute
R/C	-	Rate of Climb
TAS	-	True Airspeed
Vs	-	Stalling Speed
V_{min}	-	Minimum Aircraft Velocity
V_{max}	-	Maximum Aircraft Velocity
α	-	Angle of Attack
δ_F	-	Flap Angle
P_{T_c}	-	Total Pressure at Compressor Face
P_{T_o}	-	Total Pressure Free Stream

1. SCOPE. -

1.1 This specification covers the following aircraft:

Service Model Designation:	VZ-11
Ryan Aeronautical Company Model:	143
Crew:	1 Pilot, or 1 Pilot and passenger or observer.
Engines:	2 General Electric J85-5 Turbojets, combined with wing fans, designated as the X353-5B convertible propulsion system, and 1 X376 pitch fan.

1.1.1 The mission of the aircraft is to evaluate flight characteristics of the lift-fan propulsion system in VTOL and conventional flight modes.

2. APPLICABLE DOCUMENTS. -

2.1 The following specifications, standards, drawings, and publications dated prior to 1 June 1961 shall be used as guides in design of the aircraft detailed by this specification as modified by the following paragraphs:

2.1.1 Specifications. -

MIL-A-8806 (ASG)	Acoustical Noise Level in Aircraft, General Specification for.
MIL-A-8860	Airplane Strength and Rigidity, General Specification for.
MIL-A-8870	Airplane Strength and Rigidity, Vibration, Flutter, and Divergence.
MIL-B-5087A (ASG)	Bonding Electrical, for Aircraft.
MIL-B-8584A	Brake Systems, Wheel, Aircraft, Design of.
MIL-C-5041B	Casings, Tire and Tubeless Tires, Aircraft Pneumatic.

MIL-D-7006A (ASG)	Detecting Systems, Fire, Aircraft, Continuous Type, Installation of.
MIL-E-25499A	Electrical Systems, Aircraft, Design of, General Specification for.
MIL-E-26144	Electrical Power, Missile, Characteristics and Utilization, General Specification for.
MIL-E-5272C	Environmental Testing, Aeronautical and Associated Equipment, General Specification for.
MIL-E-5400E (ASG)	Electronic Equipment, Aircraft, General Specification for.
MIL-E-7016C	Electric Load and Power Source Capacity, Analysis of, Method for Aircraft and Missiles.
MIL-E-7017	Electrical Load Analysis, Method for Aircraft, DC.
MIL-E-7080A	Electric Equipment, Piloted Aircraft Installation and Selection of, General Specification for.
MIL-F-25352	Flutter, Divergence, and Reversal in Aircraft, Prevention of.
MIL-F-8785	Flying Qualities of Piloted Airplanes.
MIL-H-5440C	Hydraulic Systems, Aircraft Types I and II, Design, Installation, and Data Requirements for.
MIL-H-8501 A	Helicopter Flying Qualities, Requirements for.
MIL-I-6140A (ASG)	Insignia, National Aircraft.
MIL-I-7032D (ASG)	Inverter, Aircraft, General Specification for.
MIL-J-8711	Jack Pads, Aircraft, Design and Installation of.
MIL-L-5667A (ASG)	Lighting Equipment, Aircraft Instrument Panel, General Specification for Installation of.
MIL-L-6503D	Lighting Equipment, Aircraft, General Specification for Installation of.

MIL-L-6880B	Lubrication of Aircraft, General Specification for.
MIL-P-11747	Painting, Marking, and Insignia for U.S. Army Aircraft, General Specification for.
MIL-Q-9858	Quality Control System Requirements.
MIL-S-6252D	Specifications, Detail, Fixed Wing Aircraft, Preparation of.
MIL-S-8552A	Strut, Aircraft Shock Absorber, Air-Oil Type.
MIL-W-25140 (ASG)	Weight and Balance Control Data for Airplanes and Rotorcraft.
MIL-W-5013E	Wheel and Brake Assemblies, Aircraft.
MIL-W-5088B (ASG)	Wiring, Aircraft, Installation of.

2.1.2 Standards. -

MIL-STD-210A	Climatic Extremes for Military Equipment.
MIL-STD-254 (ASG)	Weight and Balance Reporting Forms for Aircraft.

2.1.3 Drawings. - There are no drawings applicable to this specification.

2.1.4 Publications. -

Air Force-Navy Aeronautical Bulletin 143	Specifications and Standards, use of.
Air Force-Navy Aeronautical Bulletin 421	Atmospheric Properties, Extreme Cold and Hot, Standard for Aeronautical Design.
MIL Handbook-5	Strength of Metal Elements.
U.S. Army TCREC-RC	Request for Quotation, Planning Purposes, for.

G.E. Specification 112, dated 15 Jan. 1962	X353-5B Convertible Propulsion System.
G.E. Specification 113, dated 1 Mar. 1962	X376 Pitch Fan System
Finish Specification for the VZ-11 Airplane	Ryan 14359-1
VZ-11 Flying Qualities	Ryan 62B062
Structural Design Criteria, VZ-11 Flight Research Aircraft	Ryan 62B094

3. REQUIREMENTS. - The characteristics and performance of this preliminary specification shall be considered as design objectives, and the Ryan Aeronautical Company shall exert best efforts to achieve said design objectives.

3.1 Characteristics. - The aircraft shall be a mid-wing, lift-fan powered research aircraft. It shall be propelled by two G.E. X353-5B propulsion systems. It shall be capable of conventional wing-supported flight at high subsonic speeds. The aircraft shall also be capable of VTOL and STOL in the fan-supported flight mode. The aircraft shall be capable of transition from zero horizontal speed to high horizontal speed and return through transition to hovering flight. It shall be capable of conventional take-off and landing. During wing-supported flight, conventional control surfaces shall be utilized. During fan-supported flight, control shall be accomplished through modulation of the air flow through the fans.

3.1.1 Aircraft Three View Drawing. - See Figure 1.

3.1.1.1 Aircraft Cutaway Drawing. - See Figure 2.

3.1.2 Aircraft Performance. - Aircraft minimum flight performance shall be in accordance with RFQ TREC-RC, Annex C, dated 31 March 1961. These performance requirements and the expected flight tests of the aircraft shall provide the basis for the performance data to be presented.

3.1.2.1 Designed Aircraft Performance.

3.1.2.1.1 VTOL Performance. - Net lift to design gross weight ratio shall not be less than 1.05 at 2,500 feet, 93.7 degrees Fahrenheit (ANA 421 Hot Day), after control power extraction. Net lift is defined as the summation of vertical forces in trimmed hover condition in or out of ground effect, whichever is less. The predicted trimmed lift capability at an intermediate C.G. location is 10,370 pounds, at 2,500 feet ANA 421 Hot Day. This provides a lift to design gross weight ratio of 1.13 after allowances are made for installation losses, power extraction, ground effects, and attitude control degradation. These allowances include a 10.6 percent gas generator bleed to power the

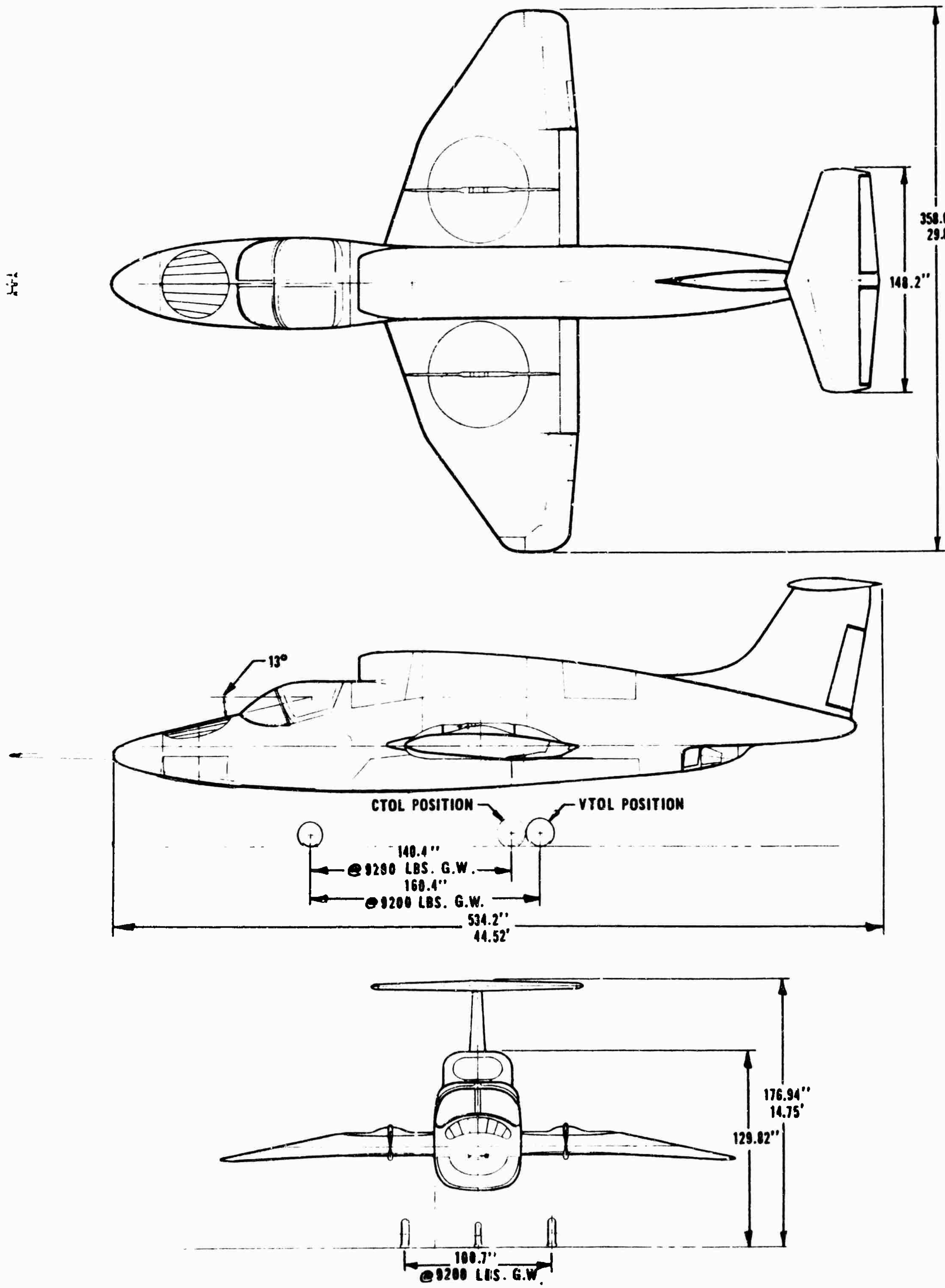


Figure 1 Three View Drawing

1. PITOT MAST
2. FIBERGLAS NOSE CONE
3. G. E. X376 PITCH CONTROL FAN
4. NOSE FAN THRUST CONTROL DOOR
5. NOSE FAN INLET CLOSURE DOORS
6. CANOPY
7. NOSE FAN SUPPLY DUCT
8. RUDDER PEDALS
9. INSTRUMENT PANEL
10. CONVENTIONAL CONTROL STICK
11. OBSERVER'S EJECTION SEAT
12. NOSE LANDING GEAR
13. THROTTLE QUADRANT
14. PILOT'S EJECTION SEAT
15. COLLECTIVE LIFT STICK
16. HYDRAULIC EQUIPMENT COMPARTMENT
17. SINGLE SPLIT ENGINE INLET DUCT
18. ELECTRICAL EQUIPMENT COMPARTMENT
19. HYDRAULIC PUMP
20. FUEL TANK
21. GENERATOR
22. RIGHT WING
23. G. E. J85-5 GAS GENERATOR
24. AILERON, R. H.
25. CROSS-OVER DUCT
26. WING FAN EXIT LOUVER ACTUATORS
27. DIVERTER VALVE
28. WING FAN INLET CLOSURE DOORS
29. G. E. X353-5 LIFT FAN
30. ENGINE TAIL PIPE
31. TWO POSITION MAIN LANDING GEAR
32. LEFT WING
33. AILERON, L. H.
34. WING FLAP, L. H.
35. THRUST SPOILERS
36. VERTICAL FIN
37. FULL MOVEABLE HORIZONTAL STABILIZER
38. SPACE PROVISION FOR ANTI-SPIN CHUTE
39. RUDDER
40. ELEVATORS

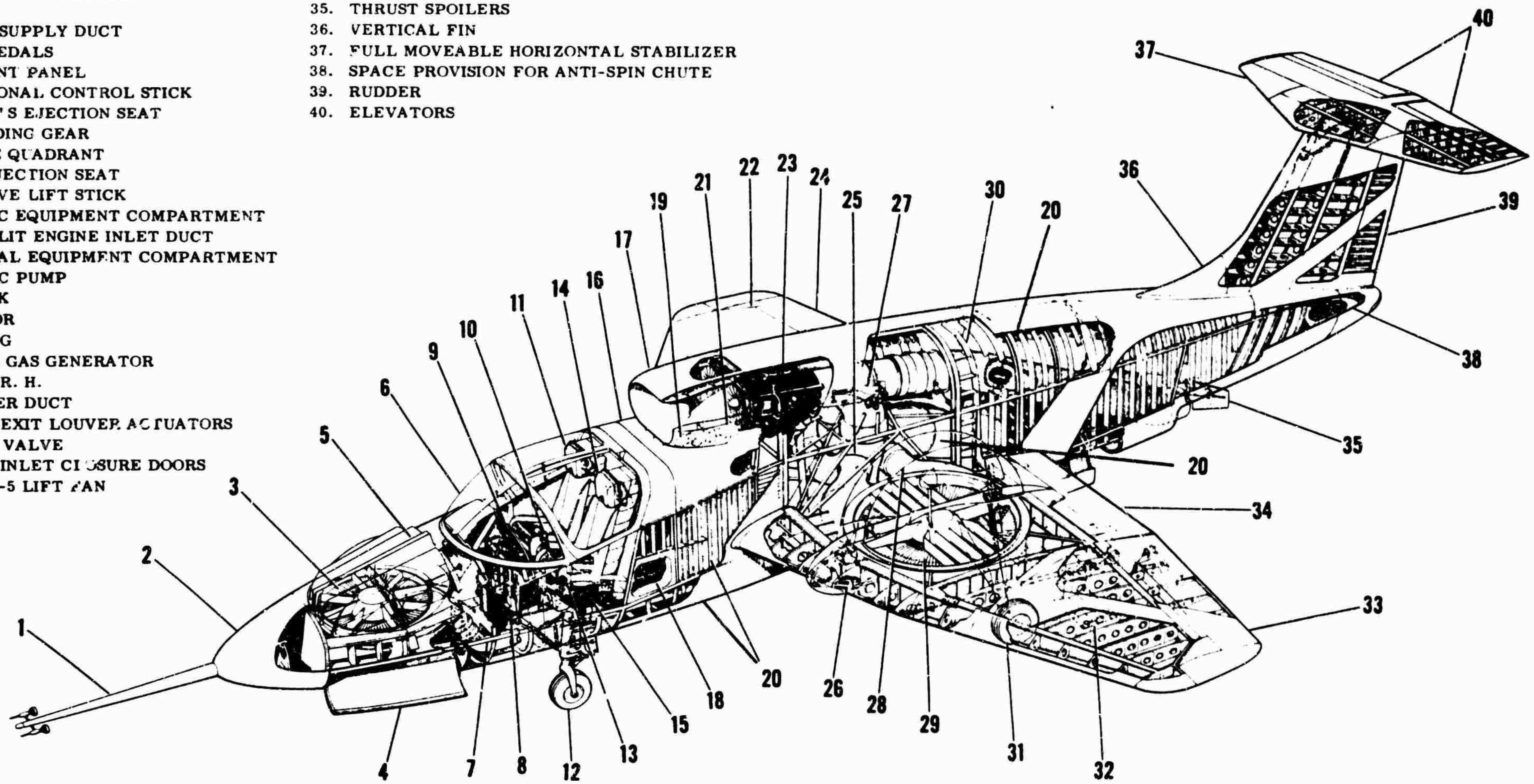


Figure 2. Aircraft Cutaway Drawing

nose fan, and provide a nose fan lift capability of approximately 1300 pounds. When using a 13.2 percent bleed factor, a lift capability of approximately 1500 pounds is produced which reduces the lift to design gross weight ratio approximately 0.03, when the center of gravity is held stationary.

3.1.2.1.2 VTOL Endurance Missions. -

3.1.2.1.2.1 Mission A. - The aircraft shall be capable of the following endurance at 2,500 feet, ANA 421 Hot Day, based on vertical take-off at a lift to weight ratio of 1.05:

(a) 5 minutes hover out of ground effect.

(b) 45 minutes flight at best endurance with both engines operating, plus (c).

(c) Reserve fuel allowance of 10 percent initial fuel weight.

3.1.2.1.2.2 Mission B. - The aircraft shall be capable of the following endurance at 2,500 feet, ANA 421 Hot Day, based on vertical take-off at a lift to weight ratio of 1.2:

(a) 5 minutes hover out of ground effect.

(b) 20 minutes conventional flight at best endurance with both engines operating, plus (c).

(c) Reserve fuel allowance of 10 percent initial fuel weight.

3.1.2.1.2.3 Flight endurance at 2,500 feet, ANA 421 Hot Day, as a function of take-off weight is shown in Figure 3. Missions A and B hover time and fuel reserve requirements are included. A flight endurance capability of 47 minutes is indicated for the design gross weight condition of Mission A. Mission B shows an endurance of 26 minutes. Information describing take-off weights and fuel expenditures for accomplishing Missions A and B are given in Table 1.

3.1.2.1.3 Transition Characteristics. - The aircraft shall be capable of vertical take-off, transition to conventional flight (out of ground effect), and transition back to vertical landing. The aircraft shall be designed to permit stopping or reversing of transition at any point, and return to the initial flight mode. The aircraft shall be capable of acceleration by the lift-fan to 120 percent of V_{stall} (based on inlet and exit louvers closed). A safe stall margin shall be provided during conversion between fan and conventional flight modes. The aircraft shall be capable of performing the entire

transition to or from conventional flight at essentially constant altitude. Transition shall be possible with landing gear extended or retracted.

3.1.2.1.3.1 Maximum speeds for one and two engines, operating in the fan flight mode, are presented as a function of gross weight in Figure 4. The landing gear is assumed retracted. Flap deflection, and effect of angle of attack are also indicated. Speed curves of 100 and 120 percent of power-off stall speed are provided. A speed capability equal to the structural limit speed of the fan system is indicated for weights up to and beyond 14,000 pounds.

3.1.2.1.3.2 Speed and power trim data for fan-flight mode are given in Figures 5 and 6 for aircraft weights of 9200 pounds and 12,500 pounds. These data are presented as a function of exit louver deflection. The effect of angle of attack is also shown.

3.1.2.1.4 Horizontal Speed Capability. - The aircraft shall possess a horizontal flight speed capability of 450 knots (TAS) at 2,500 feet ANA 421 Hot Day.

3.1.2.2 Additional Performance. -

3.1.2.2.1 Hovering Performance. - Hover lift capability is given in Figure 7 as a function of altitude for standard ARDC model atmosphere, and hot day conditions.

3.1.2.2.2 Conventional Flight Performance. - Conventional flight cruise, climb, and speed performance estimates are based on an ARDC model atmosphere except where noted.

3.1.2.2.2.1 Range performance as a function of initial weight is given in Figure 8 using an altitude limit of 10,000 feet. The range mission is described in the figure. Speed for maximum range is given in Figure 9.

3.1.2.2.2.2 Flight endurance versus initial weight is presented in Figure 10 using an altitude limitation of 10,000 feet. Endurance mission is described in the figure. Airspeed for maximum endurance at 10,000 feet is presented in Figure 11.

3.1.2.2.2.3 Maximum rate of climb for various aircraft weights as a function of altitude is presented in Figure 12. Speed for maximum rate of climb is given in Figure 13.

3.1.2.2.2.4 A speed-altitude envelope for military power is presented in Figure 14.

3.1.2.2.2.5 Available and required thrust for flight at sea level, 2500 feet, and 5000 feet in ARDC standard atmosphere is presented in Figures 15, 16, and 17 as a function of gross weight. Similar data for the hot atmosphere (ANA Bulletin No. 421) is given for altitudes of 2500 feet and 5000 feet, in Figures 18 and 19.

3.1.2.2.3 Minimum Flight Recovery Envelope. - Minimum flight recovery envelopes for one and two engines inoperative in fan-flight mode, are shown in Figure 20. The envelopes are based on accomplishment of a recovery flare with 10 feet per second rate of descent at ground contact. The data are based on an aircraft weight of 9200 pounds.

3.1.2.2.4 STOL Performance. - Runway take-off performance for the lift-fan mode is shown in Figure 21 as a function of gross weight. Data for take-off over a 50 foot obstacle is presented for sea level, and 2500 feet altitudes. (Description of STOL techniques to be added later).

3.1.2.2.5 Conventional Take-Off Distances. - Conventional take-off distances over a 50 foot obstacle are presented in Figure 22. Data for take-off at sea level, and 2500 feet altitudes are presented as a function of aircraft weight. Take-off performance is based on a 30 degree flap setting, and military power.

3.1.2.2.6 Conventional Landing Distances. - Conventional landing distances over a 50 foot obstacle are presented in Figure 23. Data for sea level and 2500 foot altitudes are shown versus aircraft weight. Landing performance is calculated using 45 degree flap setting, and idle power

3.1.2.2.7 Ferry Range. - Ferry-range, based on airspeeds and altitudes for maximum range with two engines operating, and an initial weight of 12,500 pounds, is presented in Figure 24.

3.1.2.3 Aircraft Engine Specification. - Aircraft performance specified herein is based on General Electric X353-5B Propulsion System Specification 112, dated 15 January 1962, and X376 Pitch Fan Specification 113, dated 1 March 1962.

TAKE-OFF WEIGHT VERSUS ENDURANCE
2500 FEET ANA 421 HOT DAY
CONVENTIONAL FLIGHT ENDURANCE
FOLLOWING 5 MINUTES OF HOVER
INCLUDES 10% FUEL RESERVE
GAS GENERATOR NOSE FAN BLEED = 10.6 PERCENT

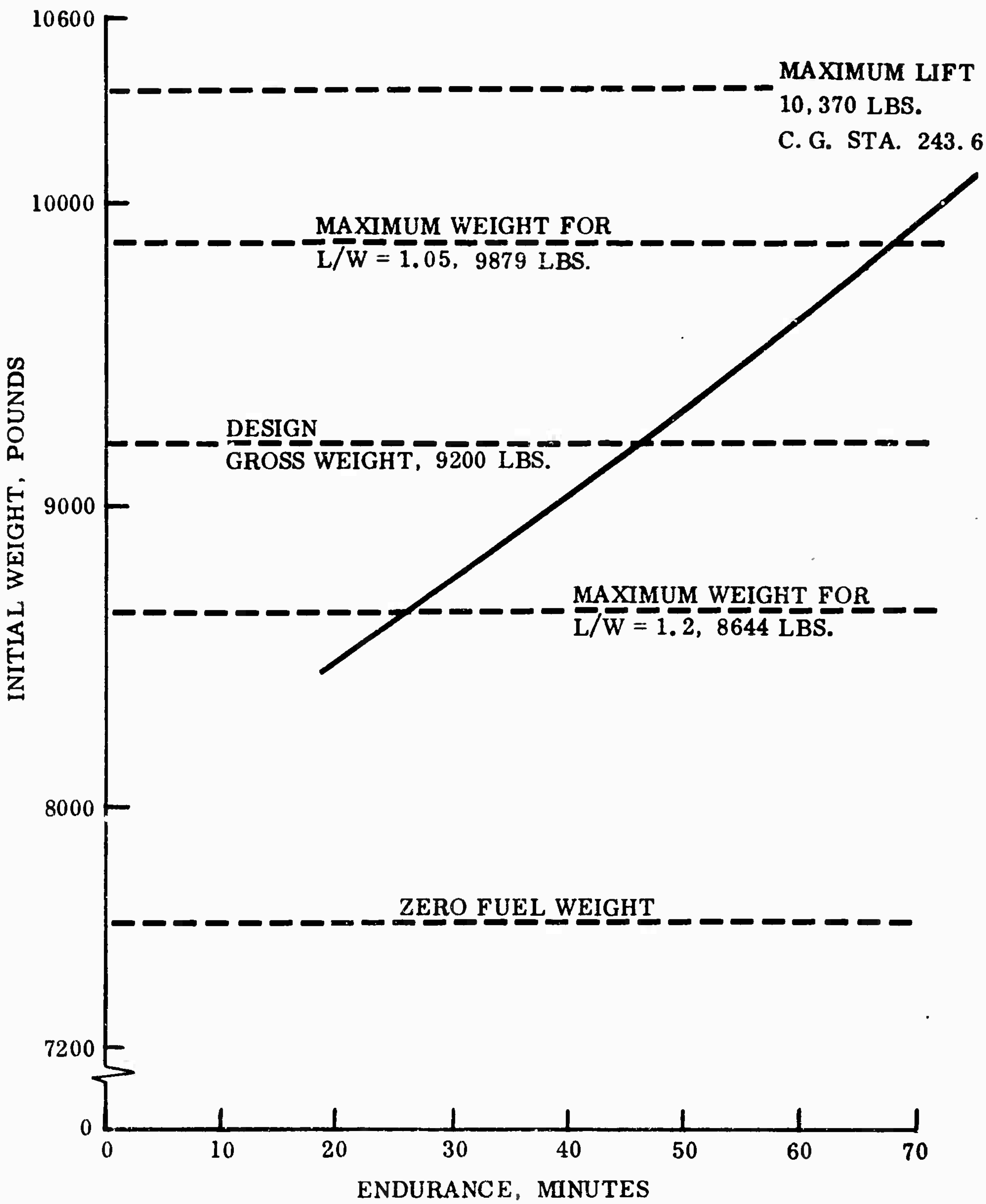


Figure 3 Take-off Weight Versus Endurance

REQUIRED VTOL MISSION PERFORMANCE 2500 FEET ANA 421 HOT DAY	L/W Ratio	Takeoff Wt. Lbs.	Fuel Used Lbs.	Time Minutes
ENDURANCE MISSION A	1.05	9145		
a. Five minutes hover out of ground effect.			329	5.0
b. Conventional flight at best endurance with both engines operating.			1049	45.0
c. Reserve fuel allowance 10% of initial fuel weight.			153	0.0
Total			1531	50.0
ENDURANCE MISSION B	1.2	8470		
a. Five minutes hover out of ground effect.			300	5.0
b. Conventional flight at best endurance with both engines operating.			470	20.0
c. Reserve fuel allowance 10% of initial fuel weight.			86	0.0
Total			856	25.0

Table 1 Required VTOL Mission Performance

FAN MODE MAXIMUM FLIGHT BOUNDARIES
SEA LEVEL ARDC STANDARD DAY
GEAR UP, MILITARY POWER
CONSTANT ALTITUDE - UNACCELERATED FLIGHT
$\delta_f = 45°$, $\beta_v = 50°$

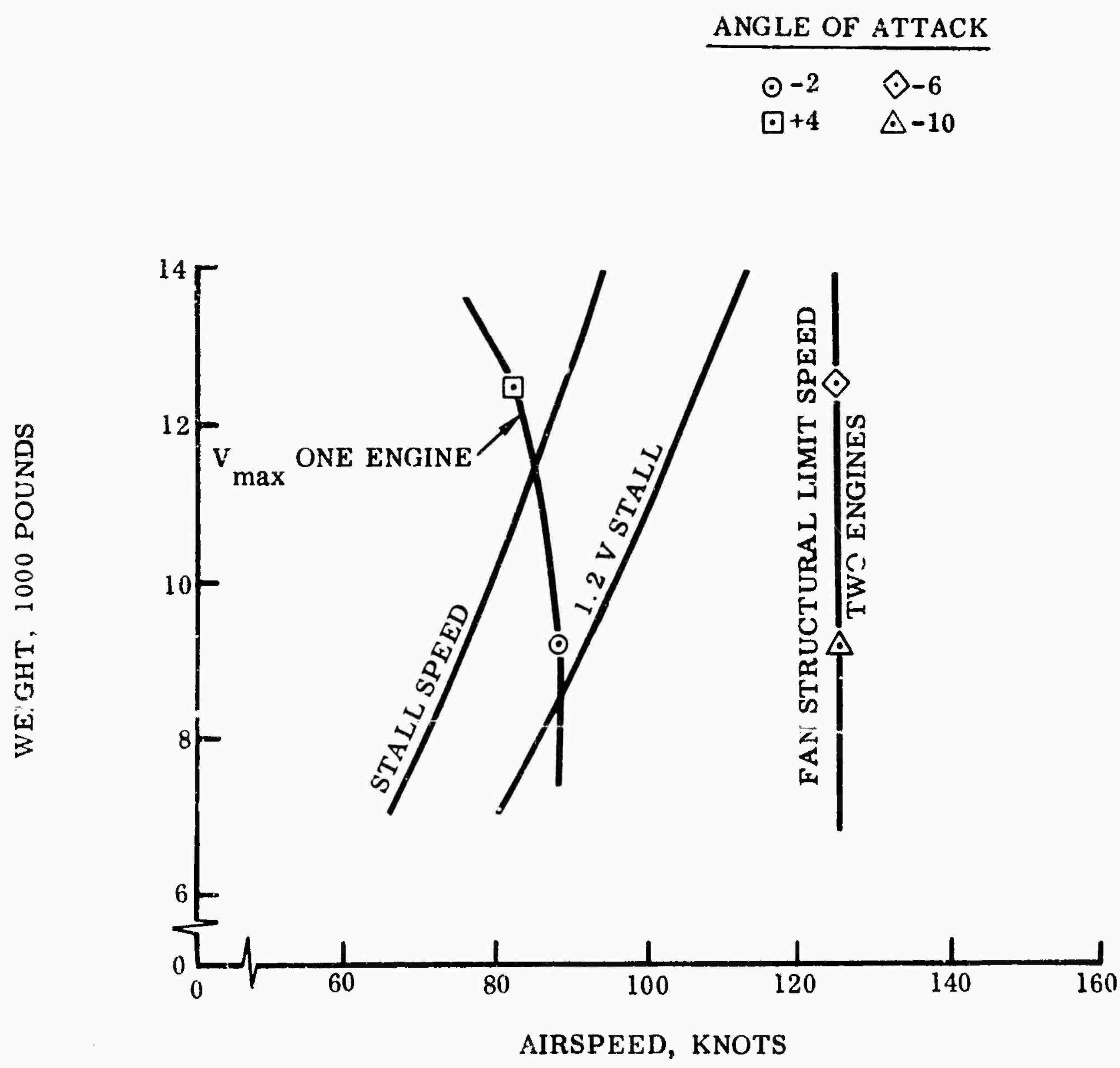


Figure 4 Fan Mode Maximum Flight Boundaries

TRANSITION TRIM CHARACTERISTICS
CONSTANT ALTITUDE-UNACCELERATED FLIGHT
SEA LEVEL ARDC STANDARD DAY
GEAR DOWN, G.W. = 9200 POUNDS, $\delta_f = 45°$

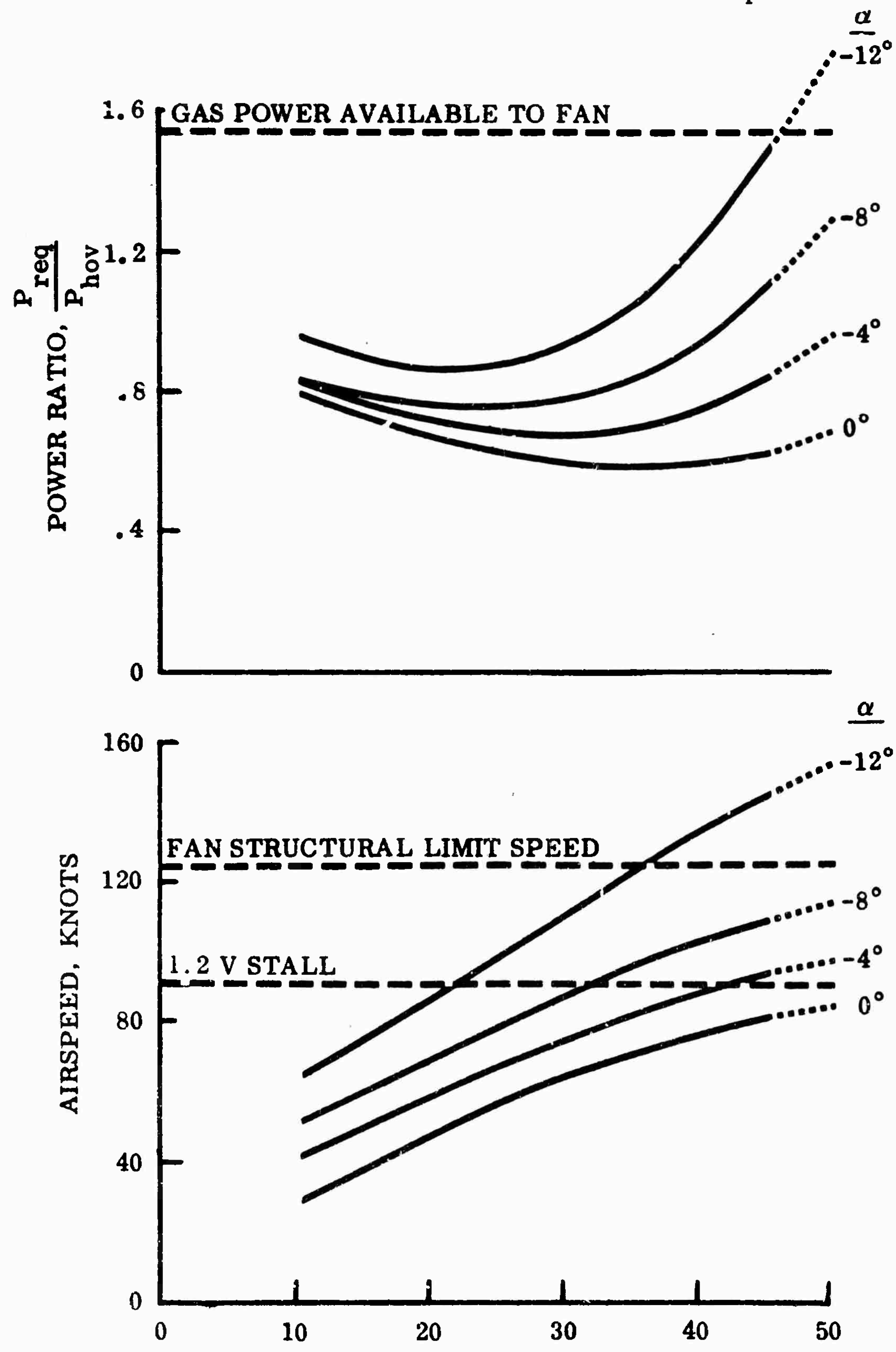


Figure 5 Transition Trim Characteristics, GW = 9200 Lbs.

TRANSITION TRIM CHARACTERISTICS
CONSTANT ALTITUDE-UNACCELERATED FLIGHT
SEA LEVEL ARDC STANDARD DAY
GEAR DOWN, G.W. = 12,600 POUNDS, $\delta_f = 45°$

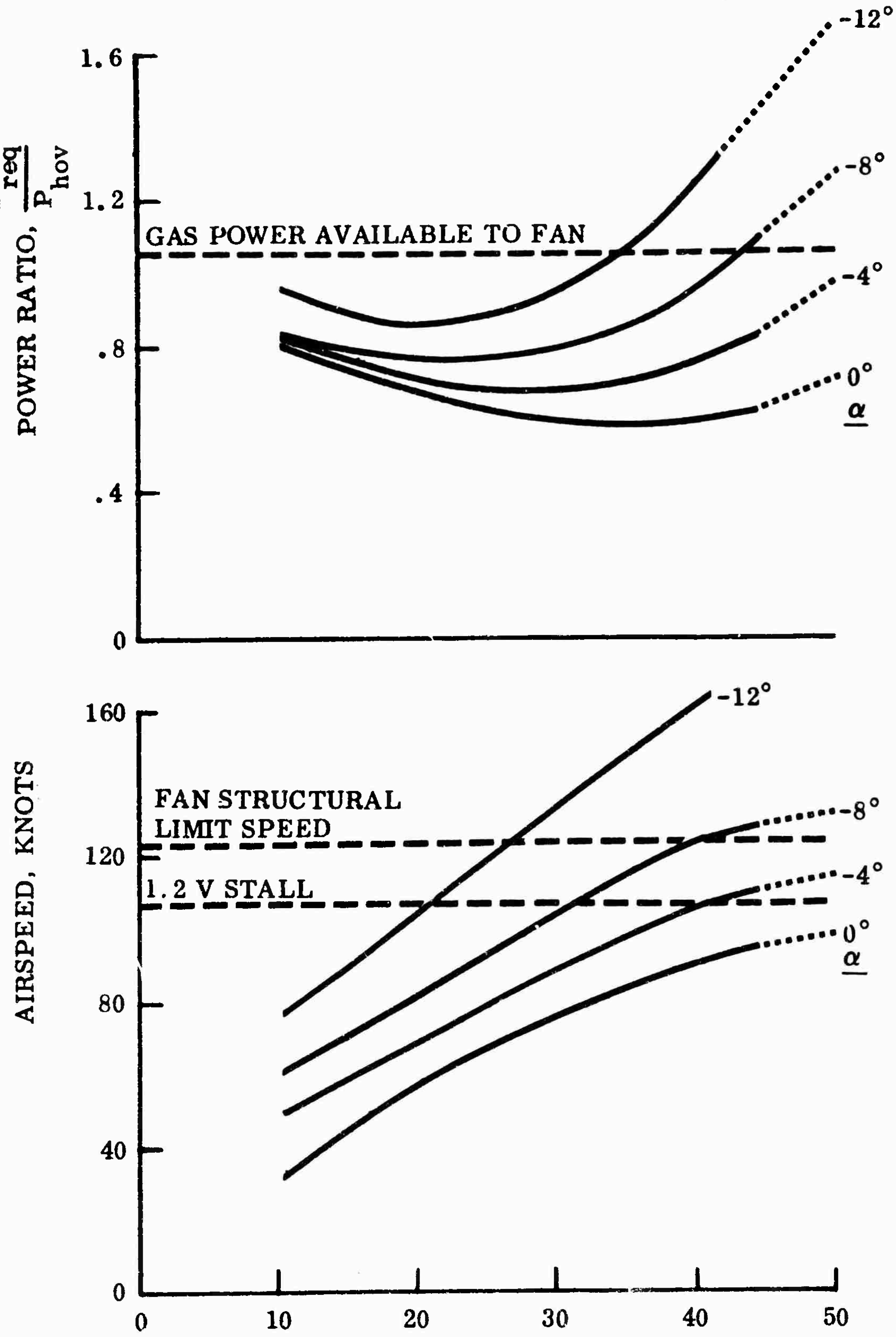


Figure 6 Transition Trim Characteristics, GW = 12,500 Lbs.

TOTAL TRIMMED LIFT VERSUS ALTITUDE
GAS GENERATOR NOSE FAN BLEED = 10. 6 PERCENT
ZERO FOREWARD VELOCITY
CENTER OF GRAVITY = STA. 243. 7

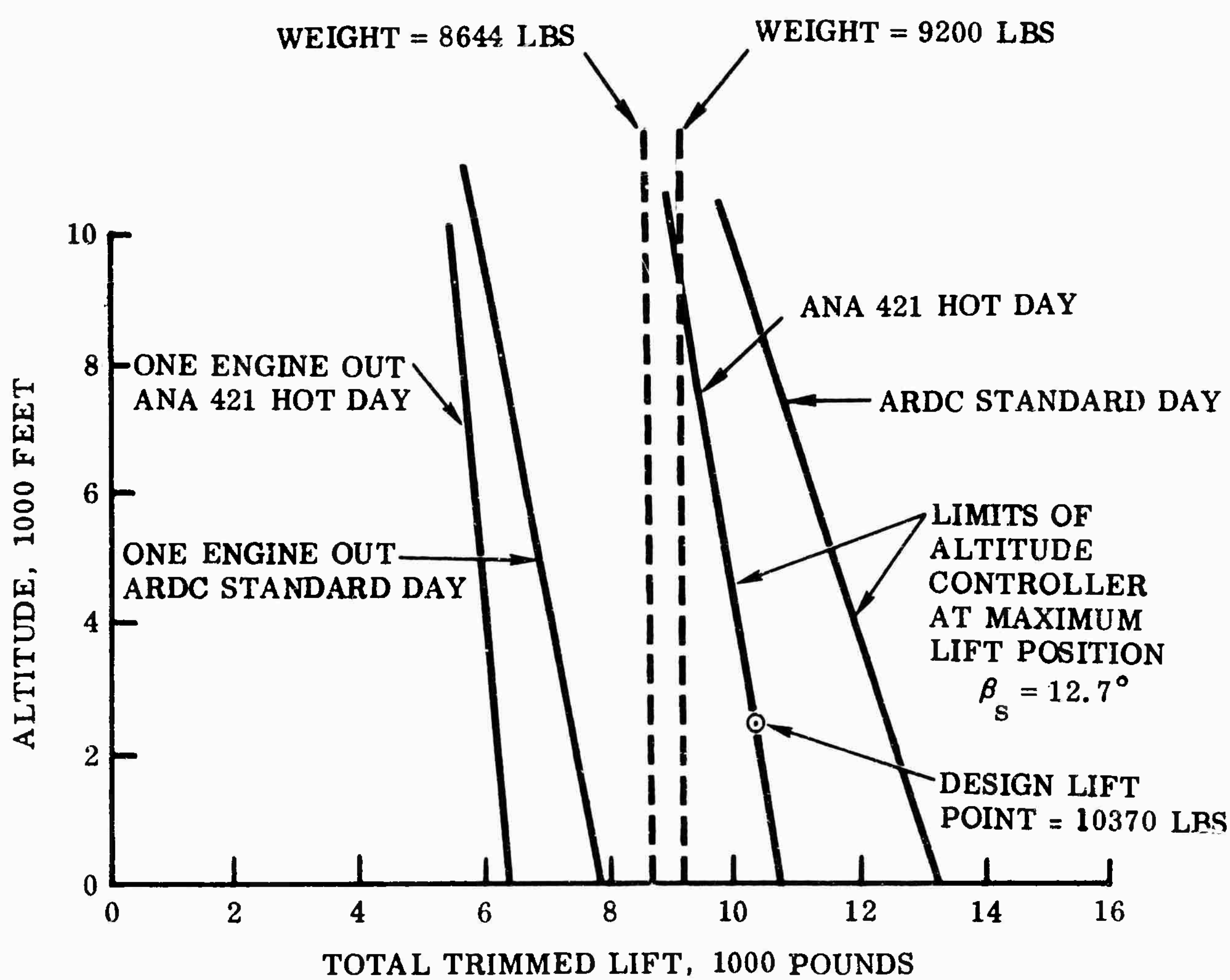


Figure 7 Total Trimmed Lift Versus Altitude

DISTANCE TRAVELED VERSUS INITIAL WEIGHT
CONVENTIONAL TAKE-OFF AND LANDING
CRUISE ALTITUDE = 10,000 FEET
TWO ENGINES OPERATING
ARDC STANDARD DAY

MISSION DESCRIPTION:

1. FUEL ALLOWANCE FOR STARTING ENGINES, TAKE-OFF, AND ACCELERATE-TO-CLIMB SPEED IS POUNDS OF FUEL USED IN 5.0 MINUTES WITH NORMAL POWER AT TAKE-OFF ALTITUDE (95% RPM).
2. CLIMB ON COURSE TO 10,000 FEET WITH MILITARY THRUST.
3. CRUISE AT AIRSPEEDS FOR MAXIMUM RANGE UNTIL 10% OF INITIAL FUEL REMAINS.
4. 10% OF INITIAL FUEL IS ALLOWED FOR RESERVE AND LANDING.

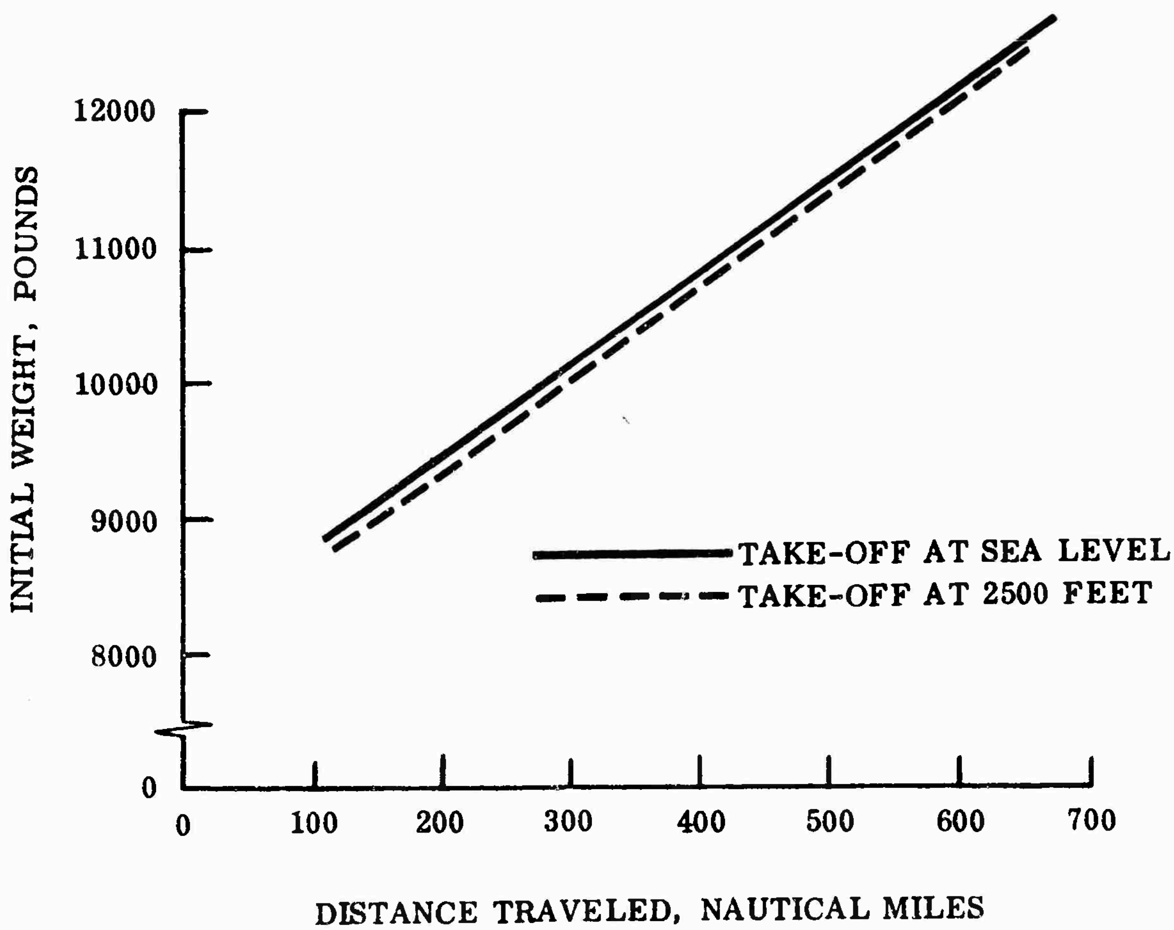


Figure 8 Distance Traveled, Versus Initial Weight

VELOCITY FOR MAXIMUM DISTANCE VERSUS WEIGHT
CONVENTIONAL TAKE-OFF AND LANDING
CRUISE ALTITUDE = 10,000 FEET
TWO ENGINES OPERATING
ARDC STANDARD DAY

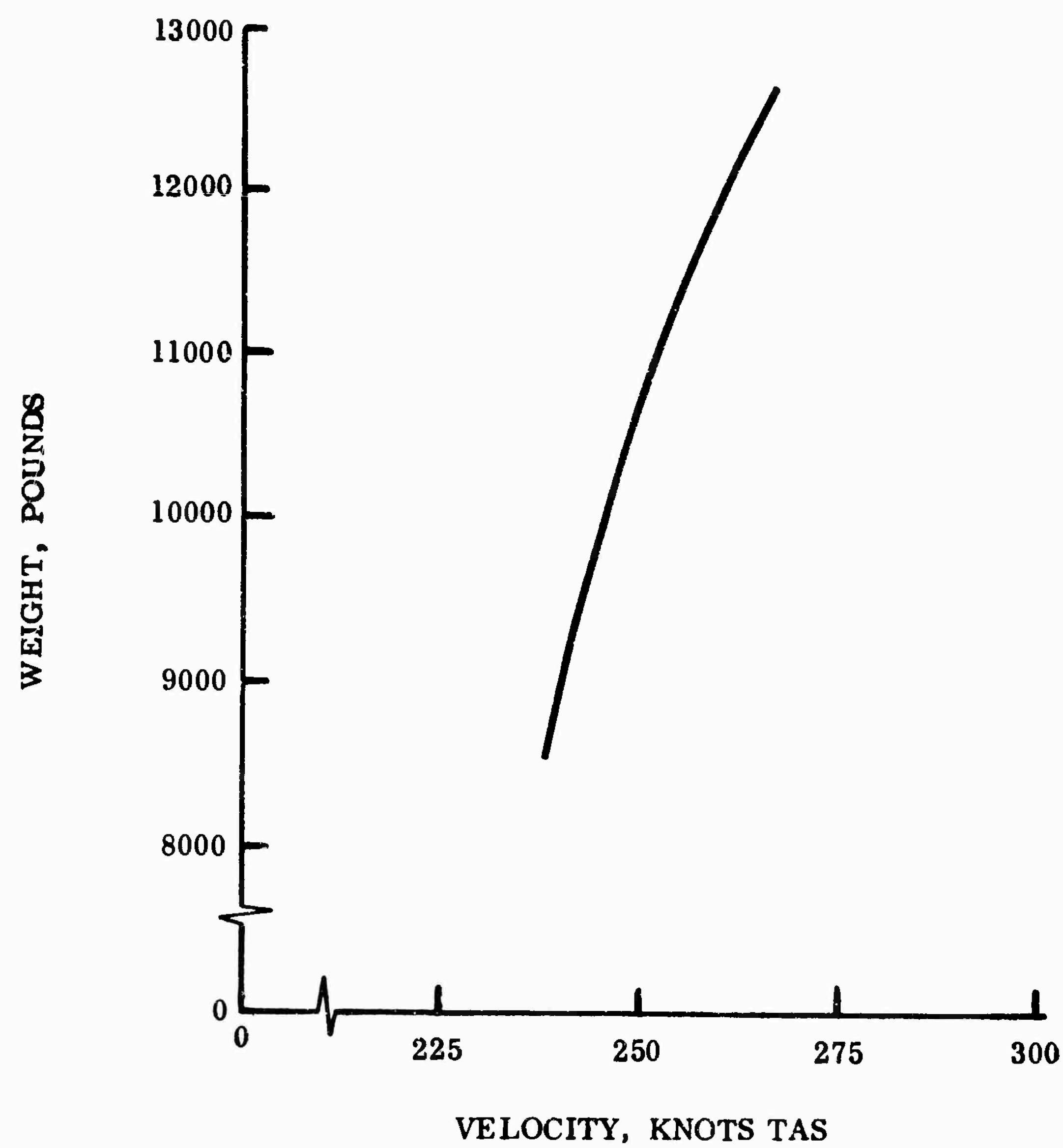


Figure 9 Velocity for Maximum Distance Versus Weight

MAXIMUM FLIGHT ENDURANCE VERSUS INITIAL WEIGHT
CONVENTIONAL TAKE-OFF AND LANDING
CRUISE ALTITUDE = 10,000 FEET
TWO ENGINES OPERATING
ARDC STANDARD DAY

MISSION DESCRIPTION:

1. FUEL ALLOWANCE FOR STARTING ENGINES, TAKE-OFF, AND ACCELERATE-TO-CLIMB SPEED IS POUNDS OF FUEL USED IN 5.0 MINUTES WITH NORMAL POWER AT TAKE-OFF ALTITUDE (95% RPM)
2. CLIMB ON COURSE TO 10,000 FT. WITH MILITARY THRUST
3. CRUISE AT AIRSPEED FOR MAXIMUM ENDURANCE UNTIL 10% OF INITIAL FUEL REMAINS.
4. 10% OF INITIAL FUEL IS ALLOWED FOR RESERVE AND LANDING.

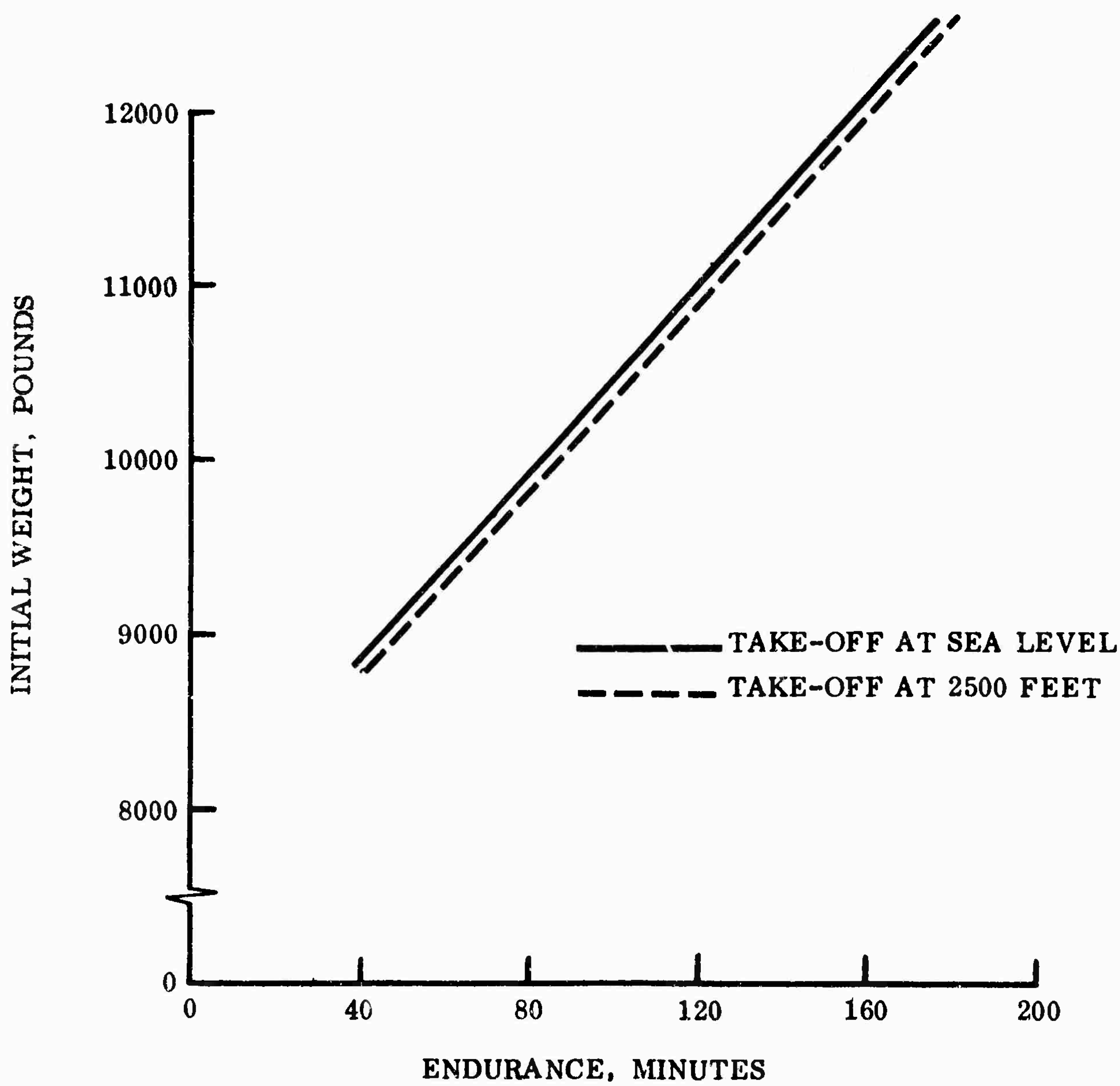


Figure 10 Maximum Flight Endurance Versus Initial Weight

VELOCITY FOR MAXIMUM FLIGHT ENDURANCE VERSUS WEIGHT
CONVENTIONAL TAKE-OFF AND LANDING
CRUISE ALTITUDE - 10,000 FEET
TWO ENGINES OPERATING
ARDC STANDARD DAY

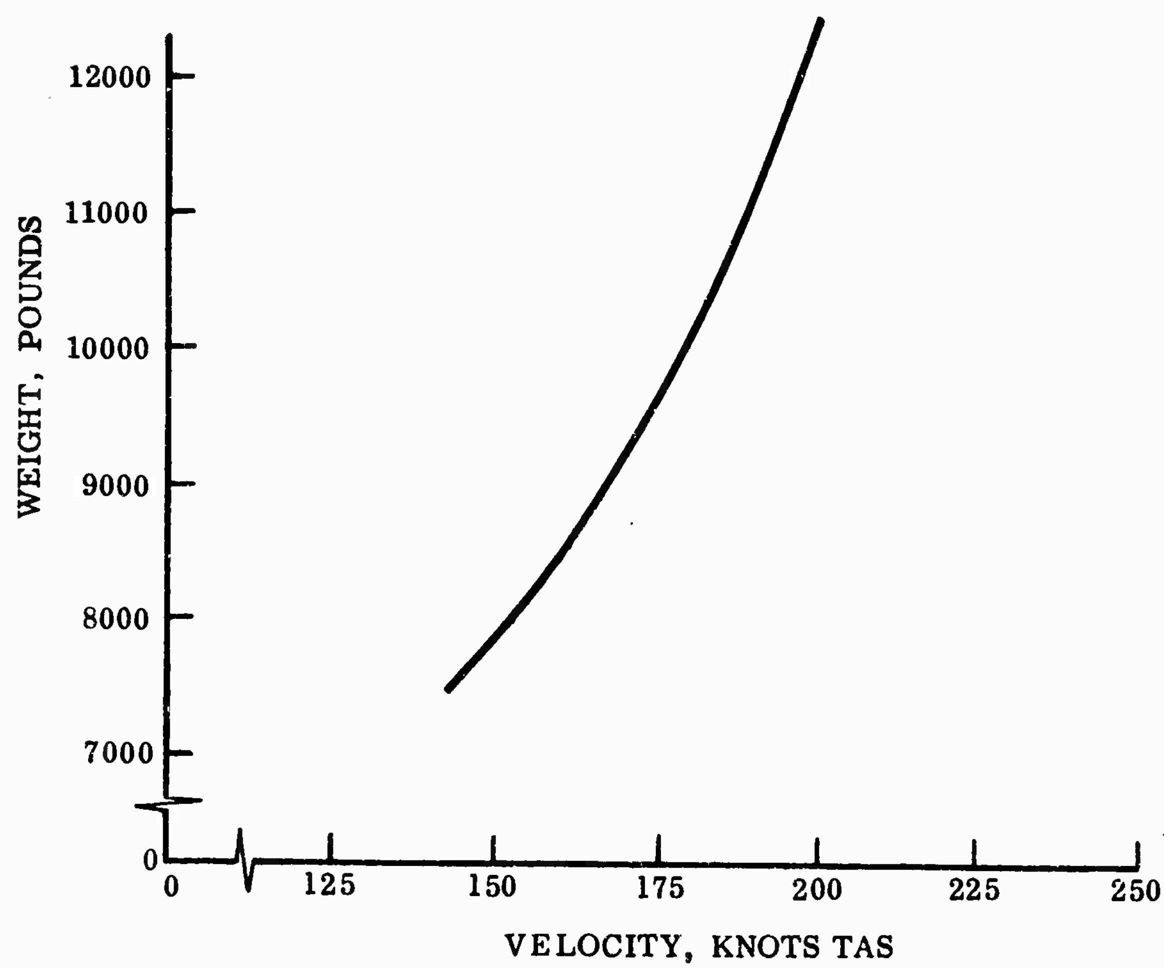


Figure 11 Velocity for Maximum Flight Endurance Versus Weight

ALTITUDE VERSUS MAXIMUM RATE OF CLIMB
100% RPM OR TEMPERATURE LIMITED
ARDC STANDARD DAY

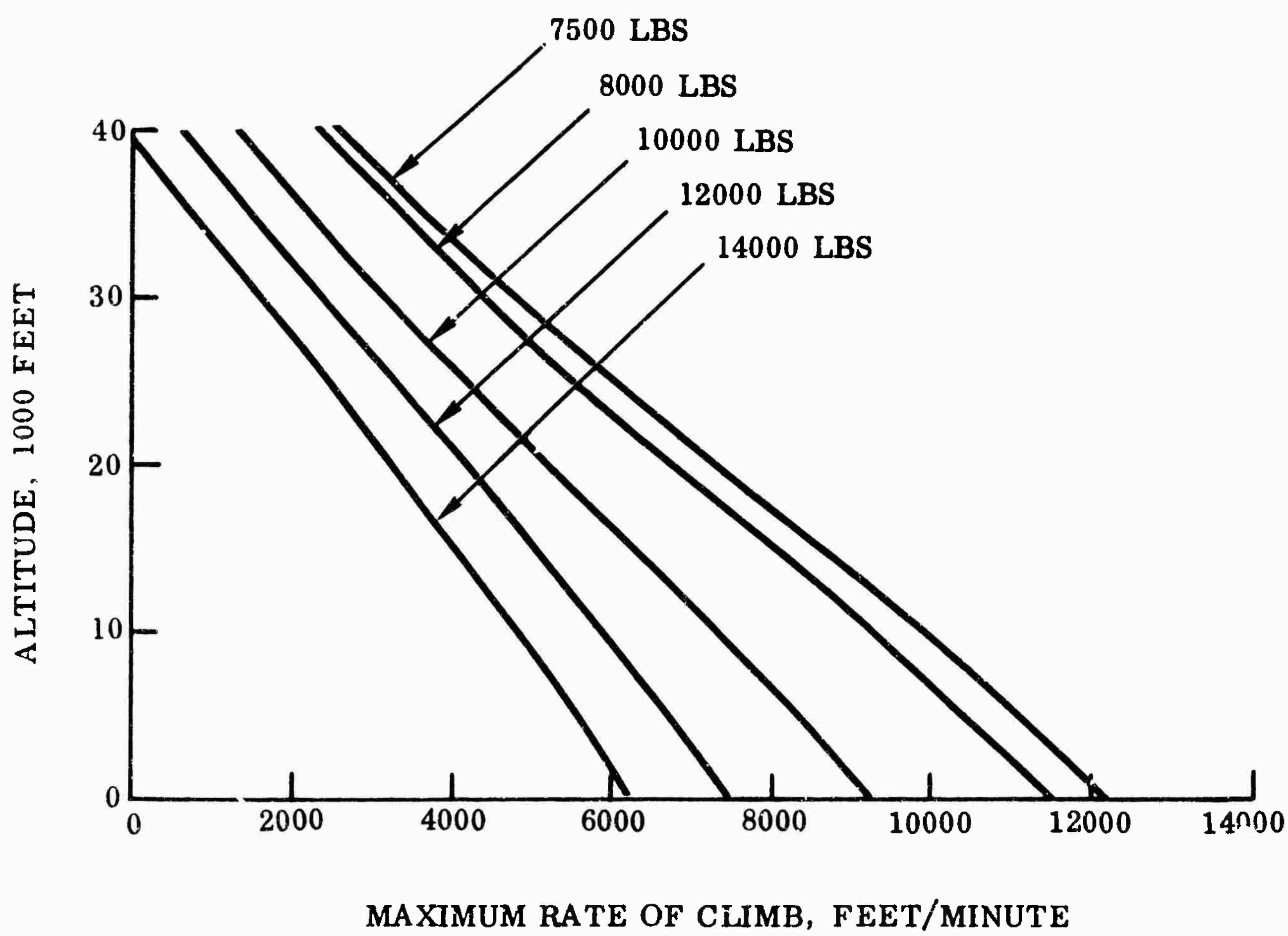


Figure 12 Altitude Versus Maximum Rate of Climb

ALTITUDE VERSUS VELOCITY FOR MAXIMUM RATE OF CLIMB
100% RPM OR TEMPERATURE LIMITED
ARDC STANDARD DAY

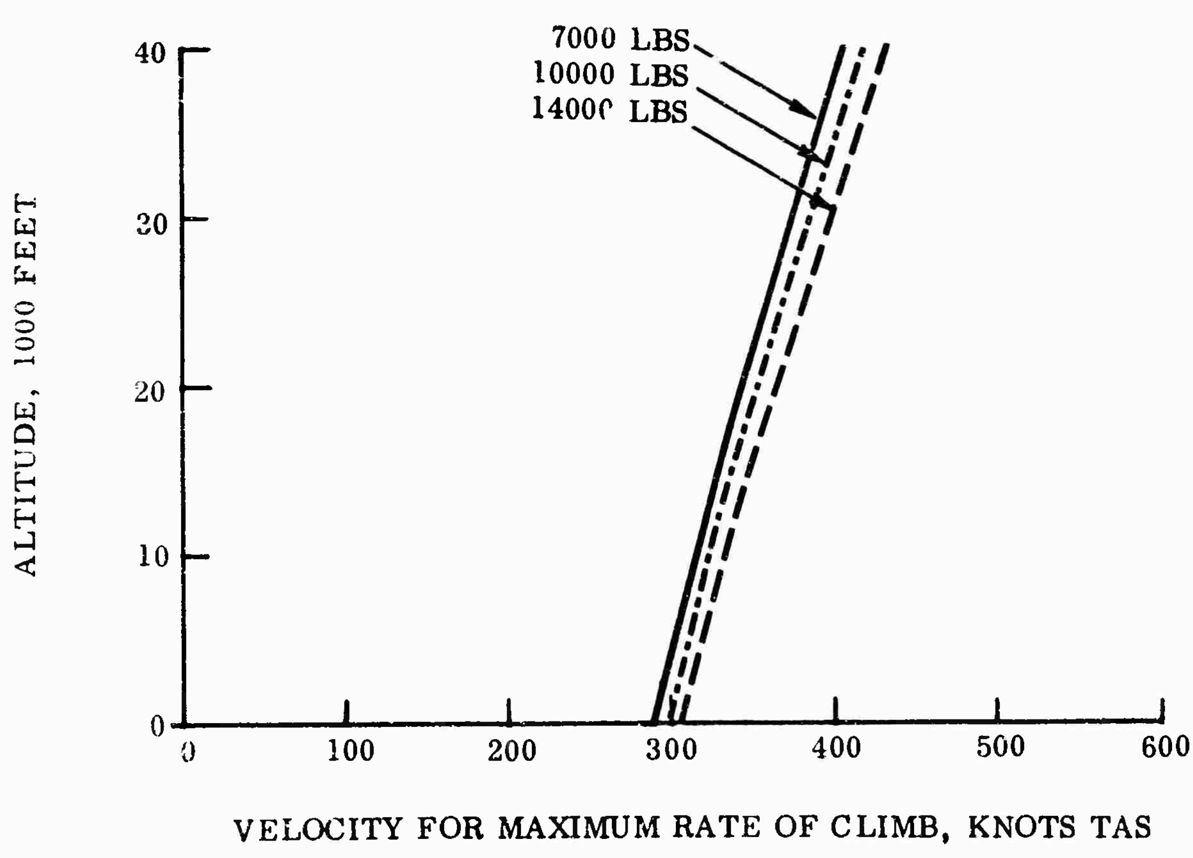


Figure 13 Altitude Versus Velocity for Maximum Rate of Climb

SPEED-ALTITUDE ENVELOPE
100% RPM OR TEMPERATURE LIMITED
RATE OF CLIMB = 0
ARDC STANDARD DAY

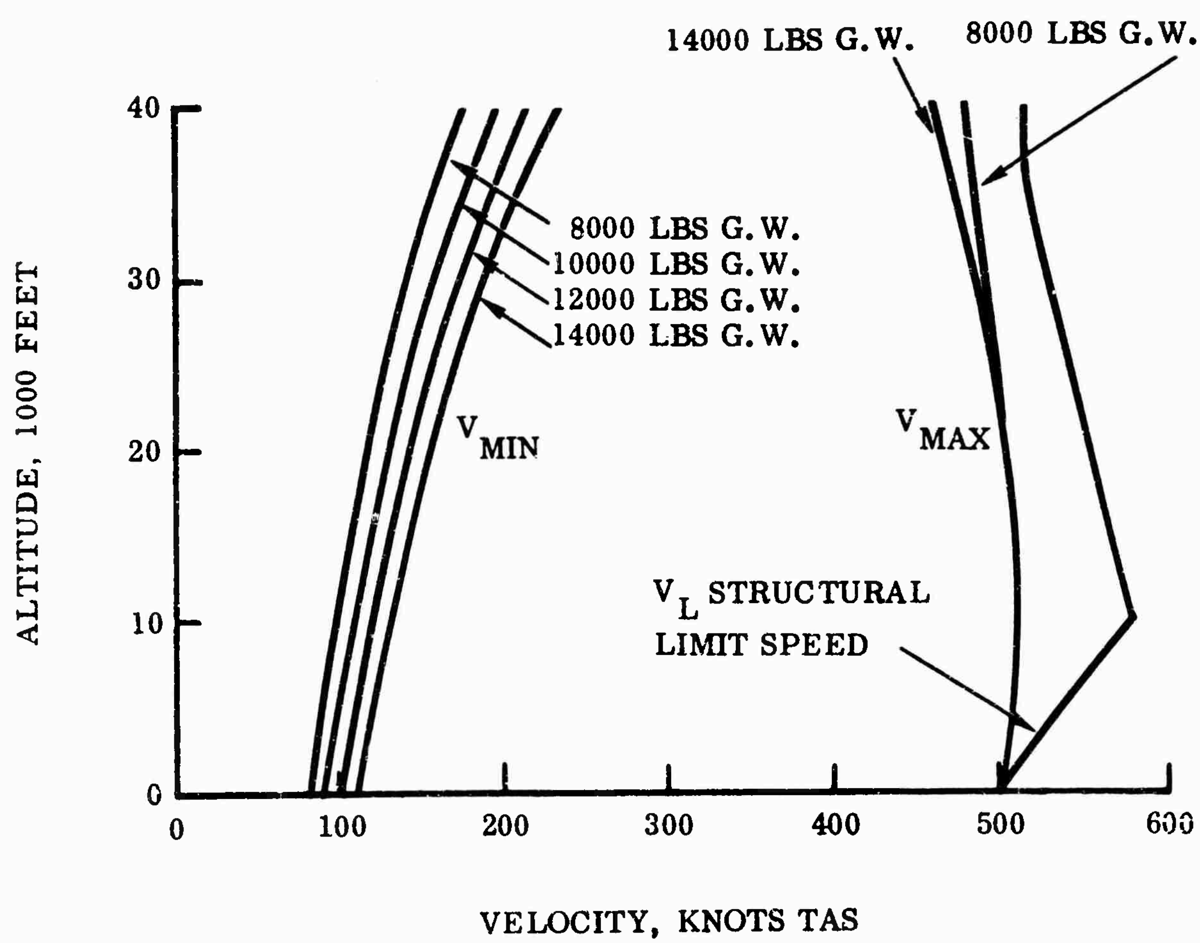


Figure 14 Speed - Altitude Envelope

THRUST REQUIRED AND AVAILABLE VERSUS VELOCITY
SEA LEVEL ARDC STANDARD DAY

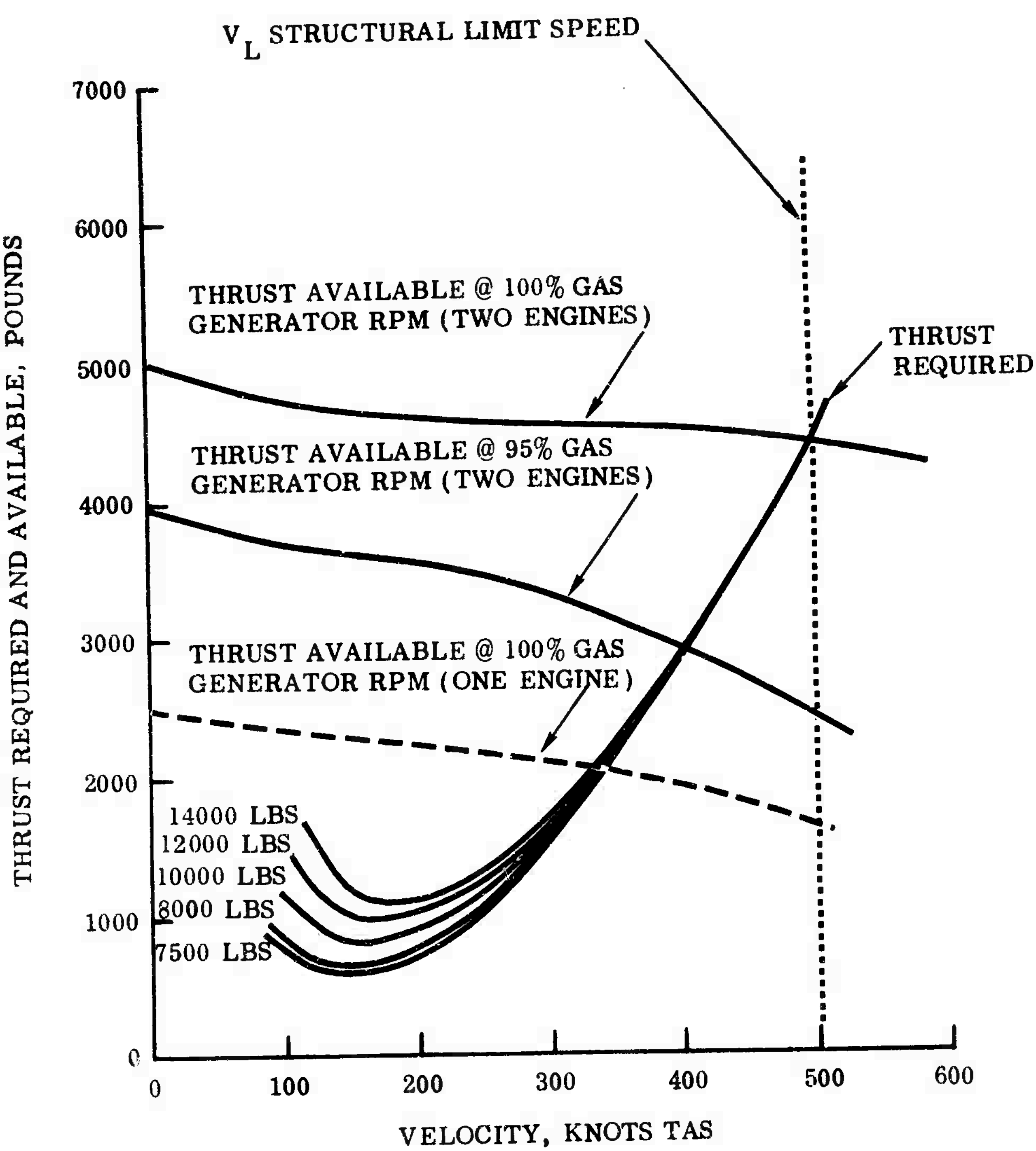


Figure 15 Thrust Required and Available Versus Velocity, Sea Level ARDC Standard Day

THRUST REQUIRED AND AVAILABLE VERSUS VELOCITY
2500 FEET ARDC STANDARD DAY

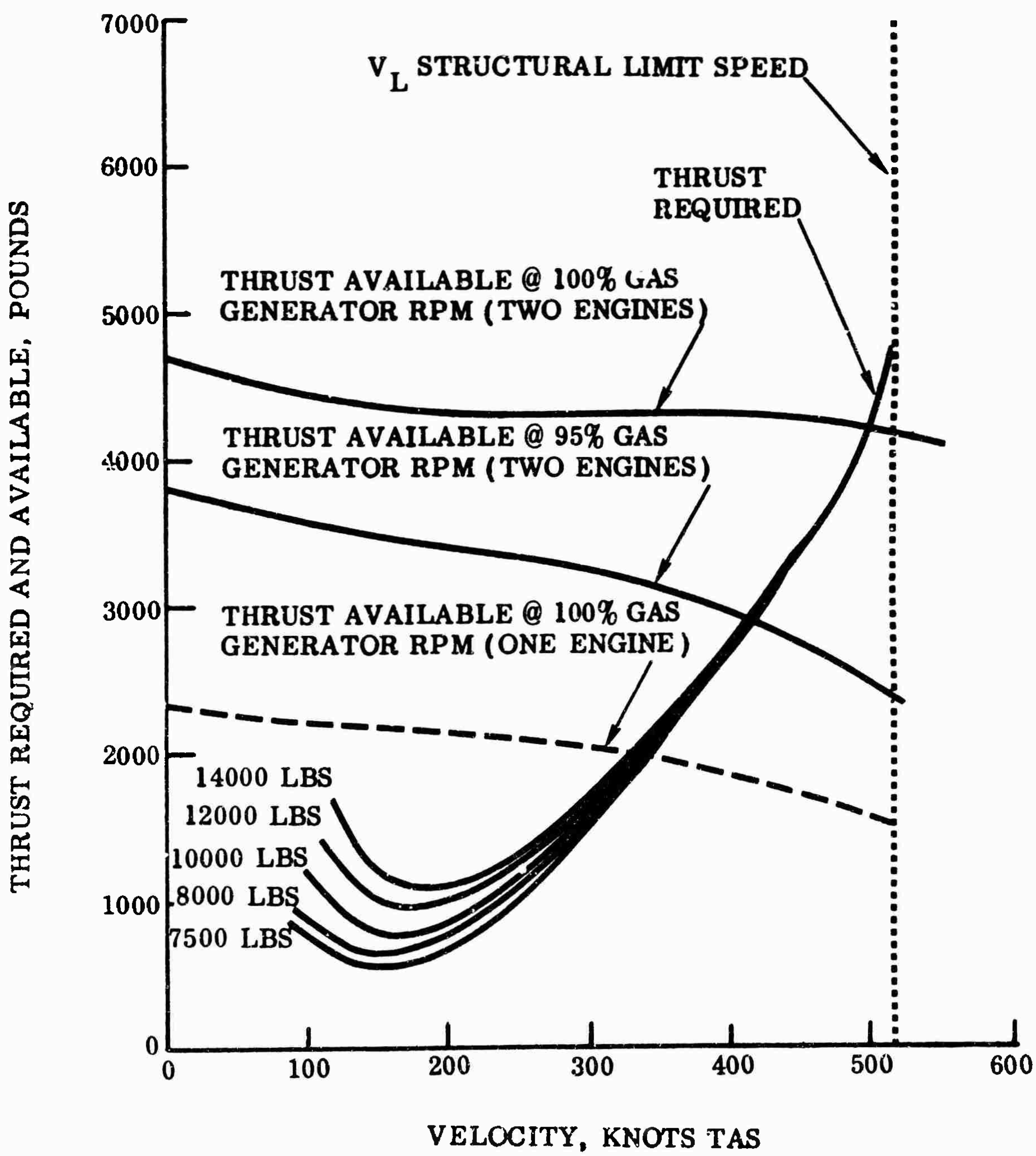


Figure 16 Thrust Required and Available Versus Velocity,
2500 Feet ARDC Standard Day

THRUST REQUIRED AND AVAILABLE VERSUS VELOCITY
5000 FEET ARDC STANDARD DAY

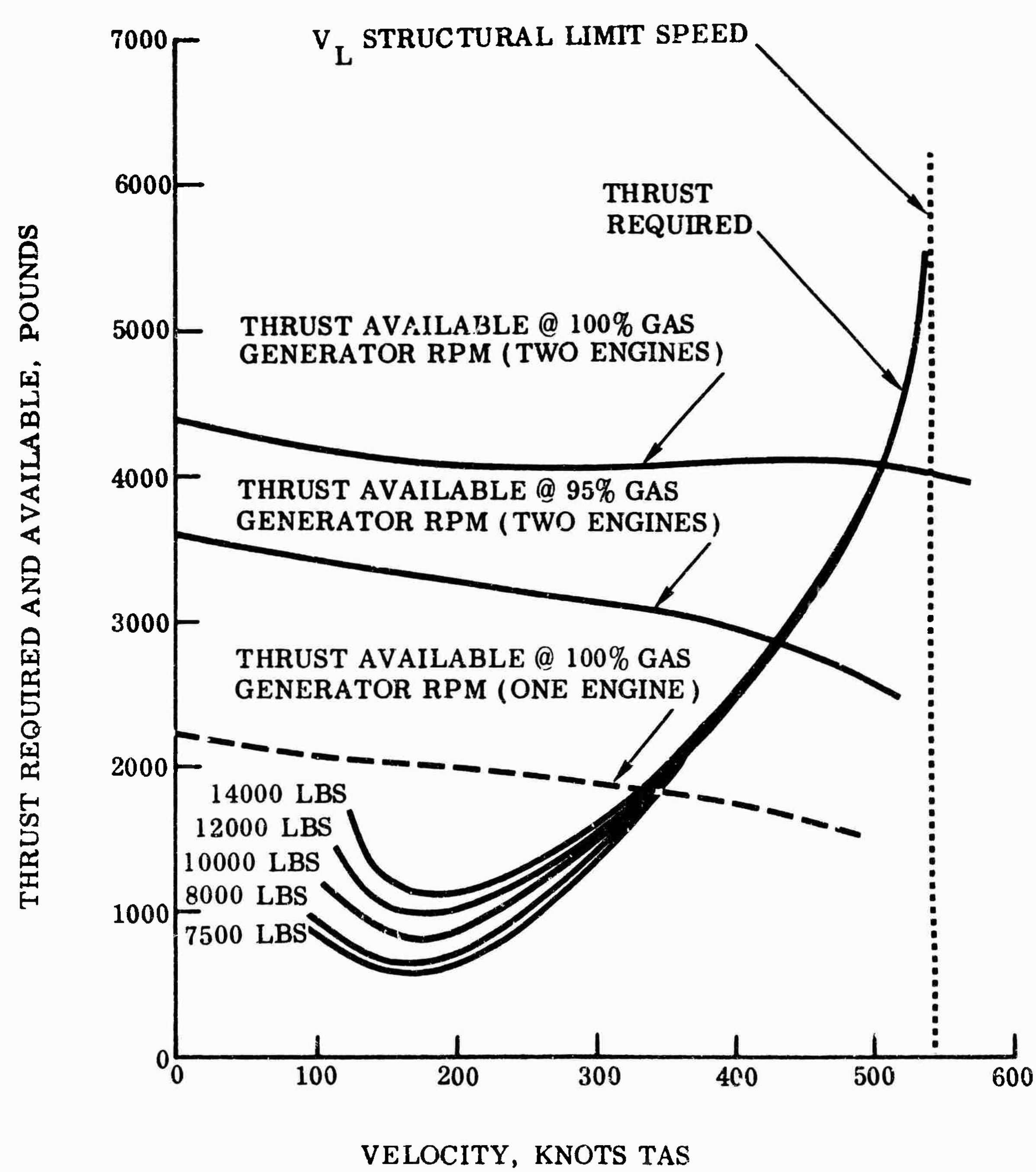


Figure 17 Thrust Required and Available Versus Velocity, 5000 Feet ARDC Standard Day

THRUST REQUIRED AND AVAILABLE VERSUS VELOCITY
2500 FEET ANA 421 HOT DAY

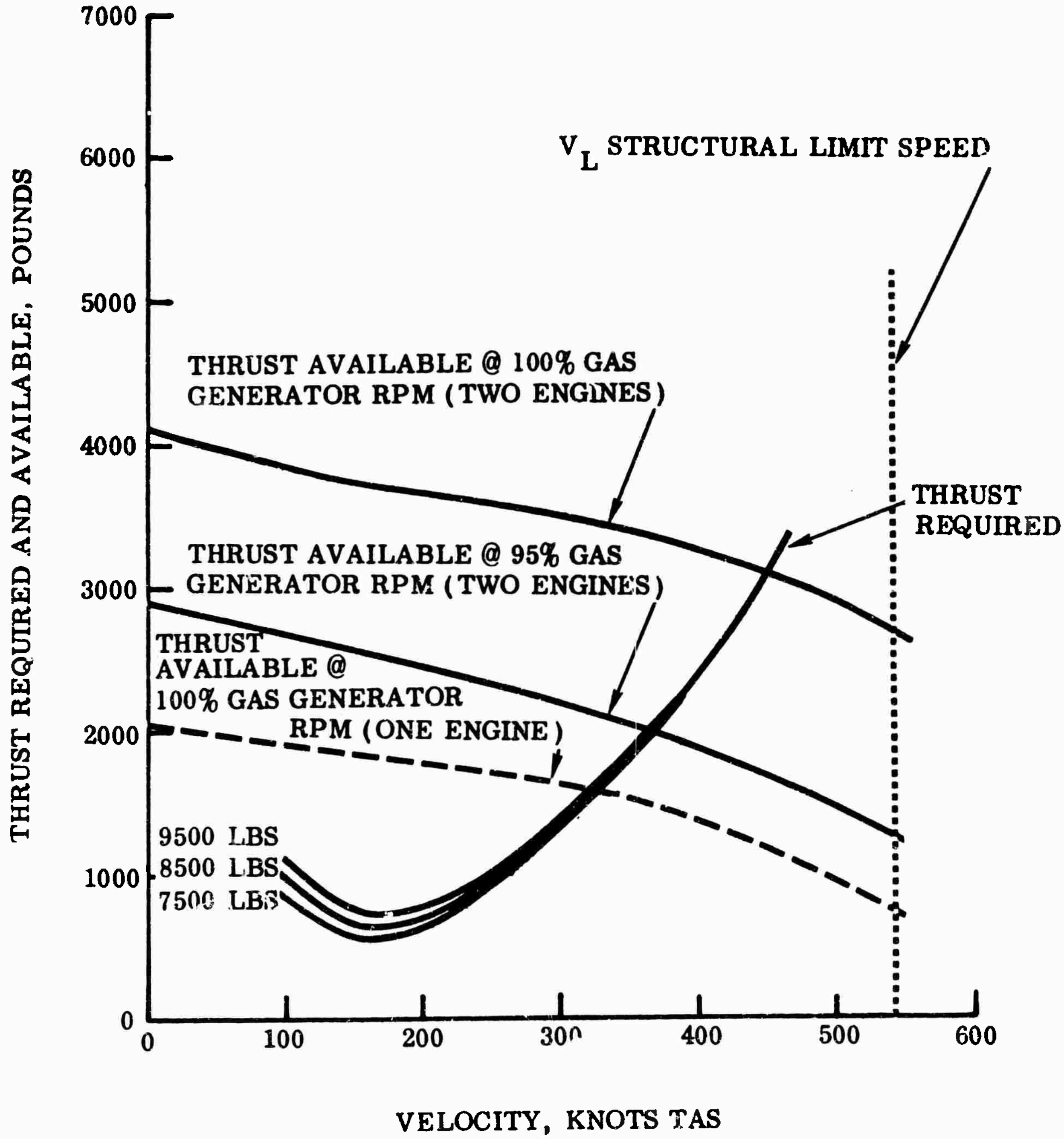


Figure 18 Thrust Required and Available Versus Velocity, 2500 Feet ANA 421 Hot Day

THRUST REQUIRED AND AVAILABLE VERSUS VELOCITY
5000 FEET ANA 421 HOT DAY

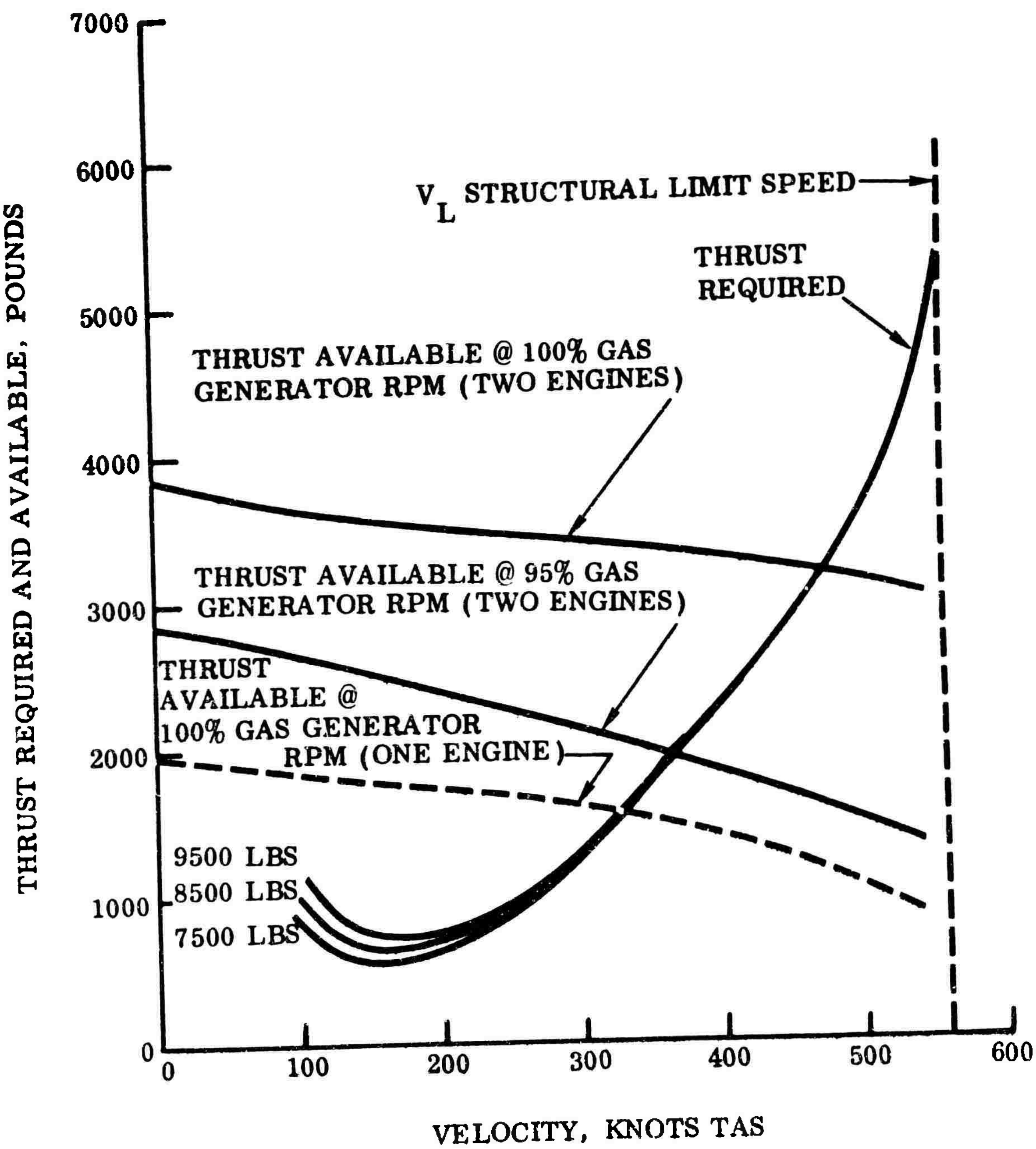


Figure 19 Thrust Required and Available Versus Velocity, 5000 Feet ANA 421 Hot Day

ESTIMATED FLIGHT RECOVERY ENVELOPES
SEA LEVEL ARDC STANDARD DAY
GROSS WEIGHT = 9200 POUNDS
FLARE MANEUVER BASED ON 1.1 V_{STALL} FOR TWO ENGINES OUT

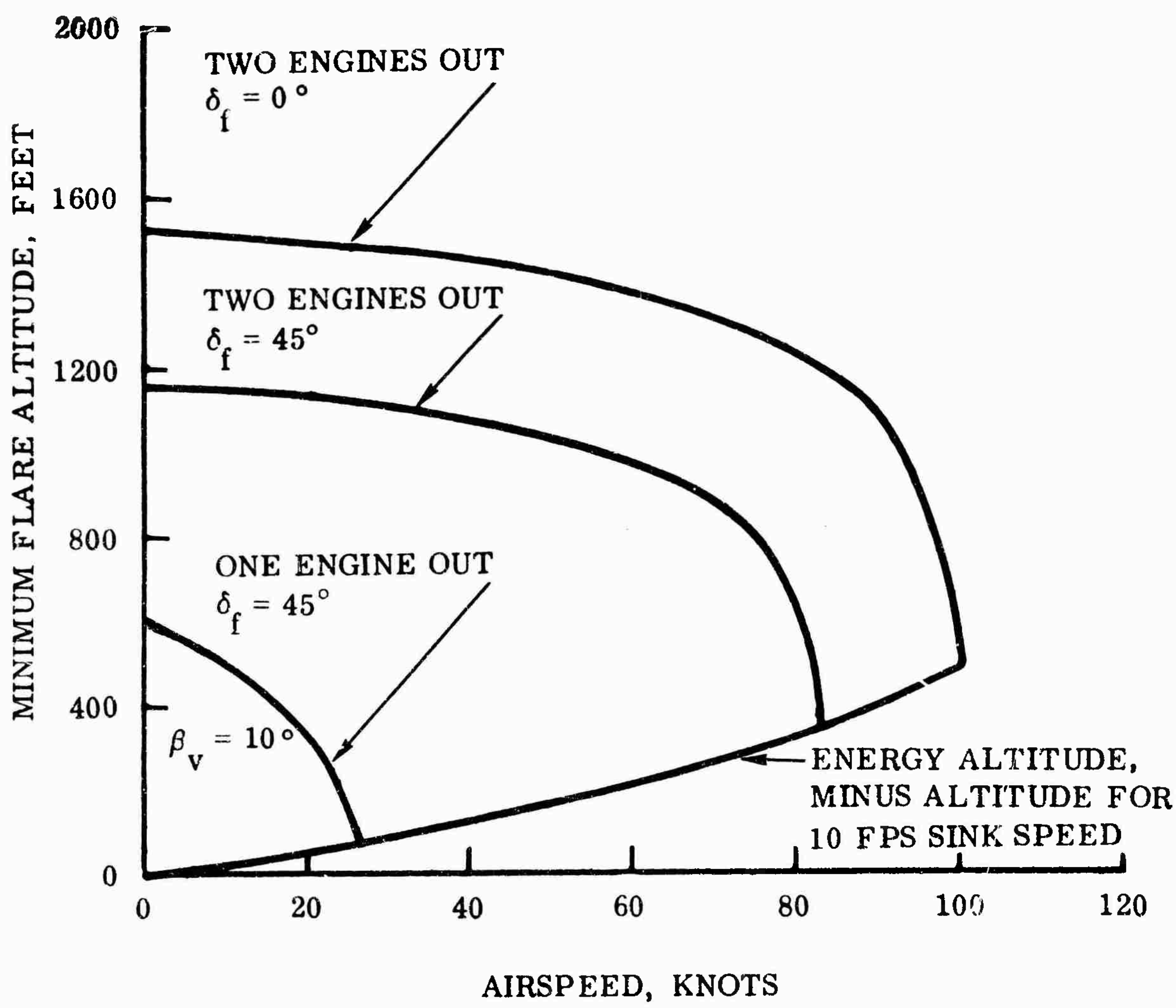
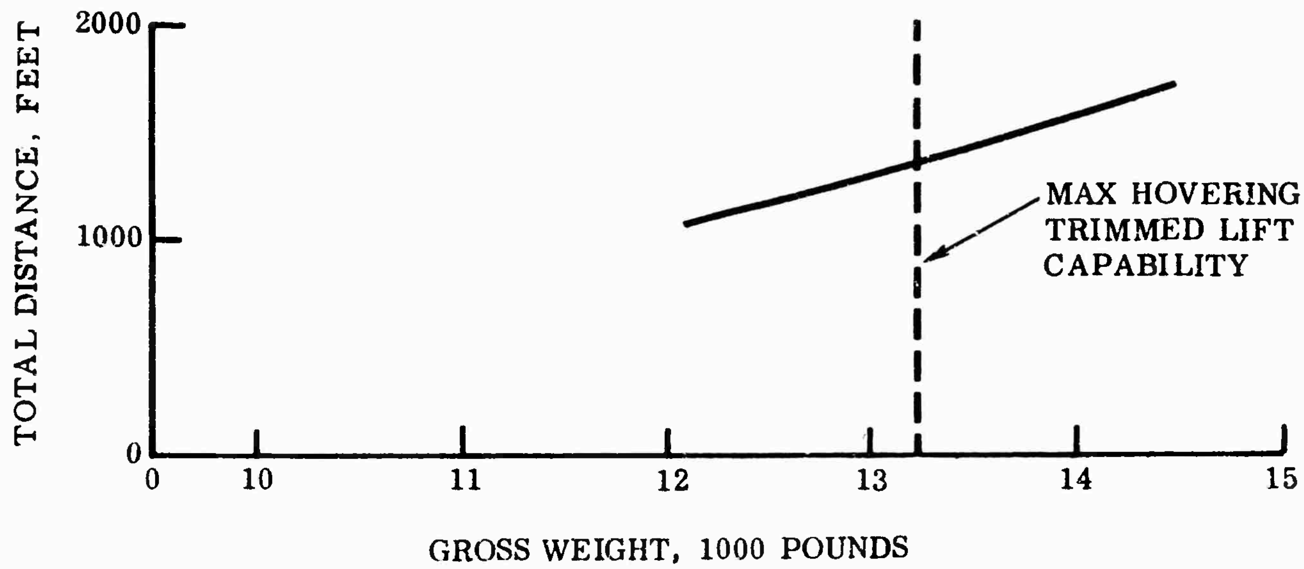


Figure 20 Estimated Flight Recovery Envelopes

STOL TAKE-OFF DISTANCE OVER 50 FOOT OBSTACLE
ARDC STANDARD DAY
MILITARY POWER
$\delta_f = 45°$ $\beta_v = 40°$

SEA LEVEL



2500 FEET

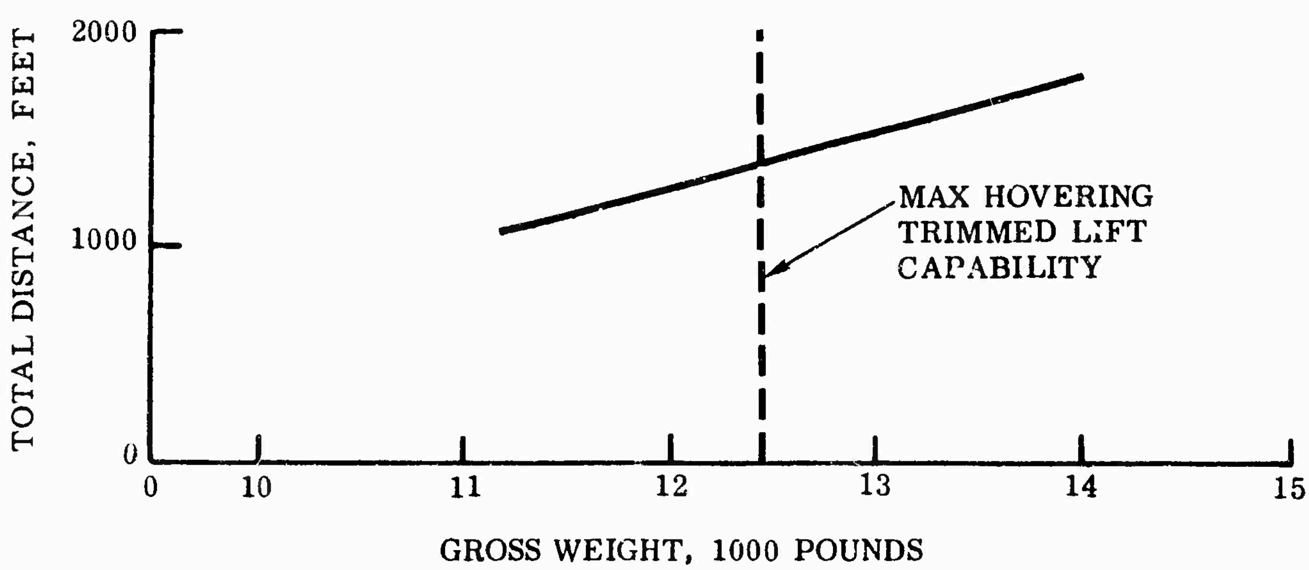


Figure 21 STOL Take-off Distance Over 50 Foot Obstacle

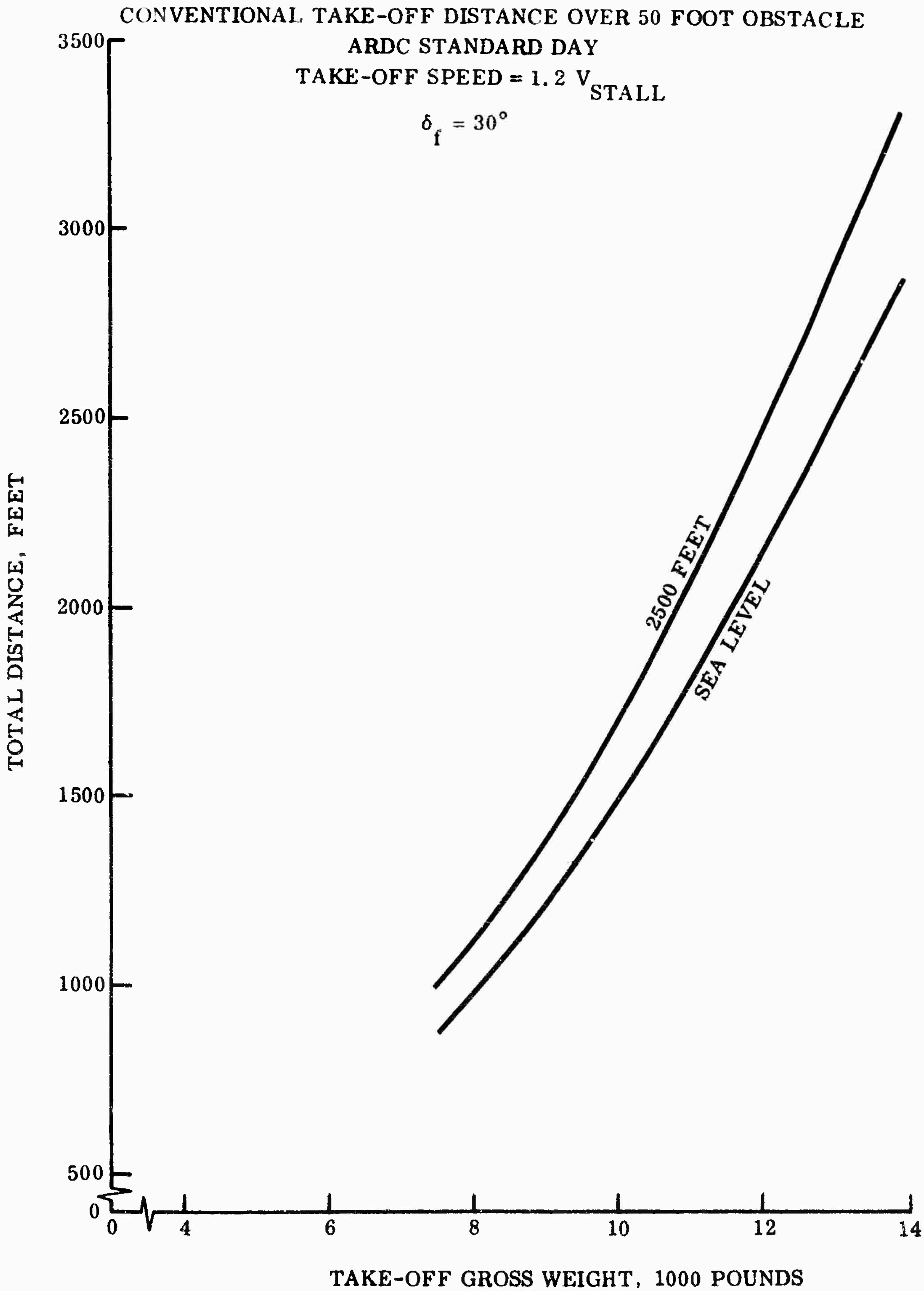
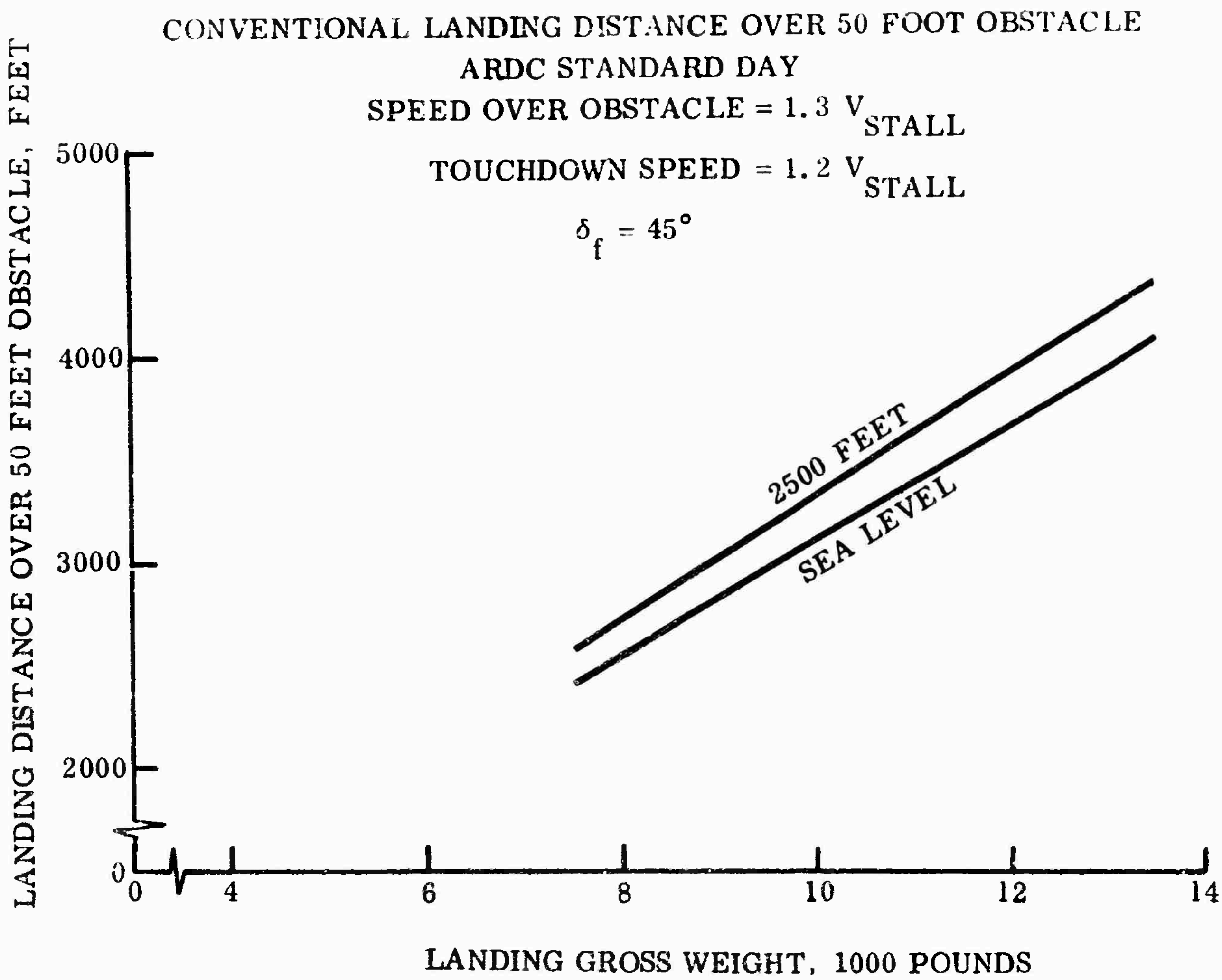


Figure 22 Conventional Take-off Distance Over 50 Foot Obstacle



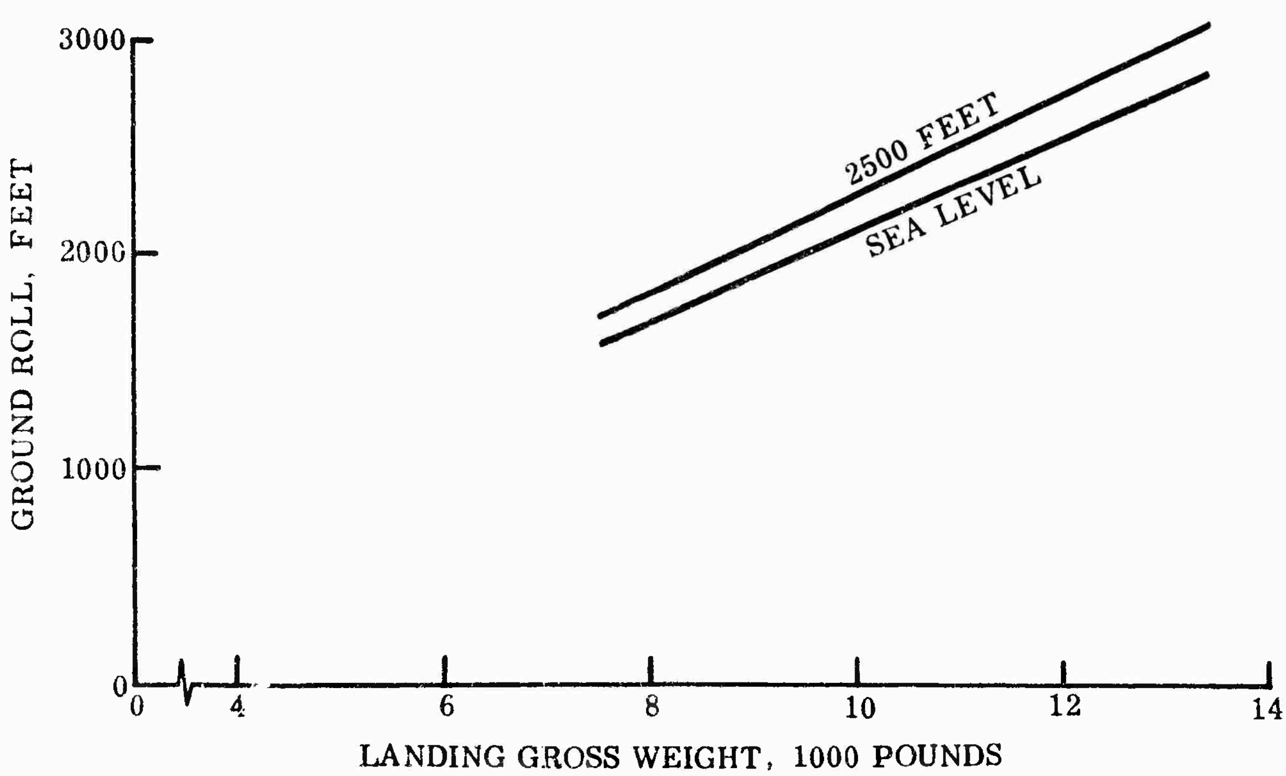


Figure 23 Conventional Landing Distance Over 50 Foot Obstacle

FERRY DISTANCE
ARDC STANDARD DAY
CONVENTIONAL TAKE-OFF FROM SEA LEVEL

NOTES:

1. TAKE-OFF WEIGHT 12,500 POUNDS
2. TOTAL INTERNAL FUEL 4886 POUNDS
3. FUEL ALLOWANCE FOR STARTING ENGINES, TAKE-OFF, AND ACCELERATE-TO-CLIMB SPEED IS POUNDS OF FUEL USED IN 5.0 MINUTES WITH NORMAL POWER AT SEA LEVEL (95% RPM)
4. CLIMB ON COURSE TO CRUISE ALTITUDE WITH MILITARY THRUST
5. CRUISE AT AIRSPEED FOR MAXIMUM RANGE UNTIL 10% OF INITIAL FUEL REMAINS
6. FUEL ALLOWANCE FOR RESERVE AND LANDING IS 10% OF INITIAL FUEL

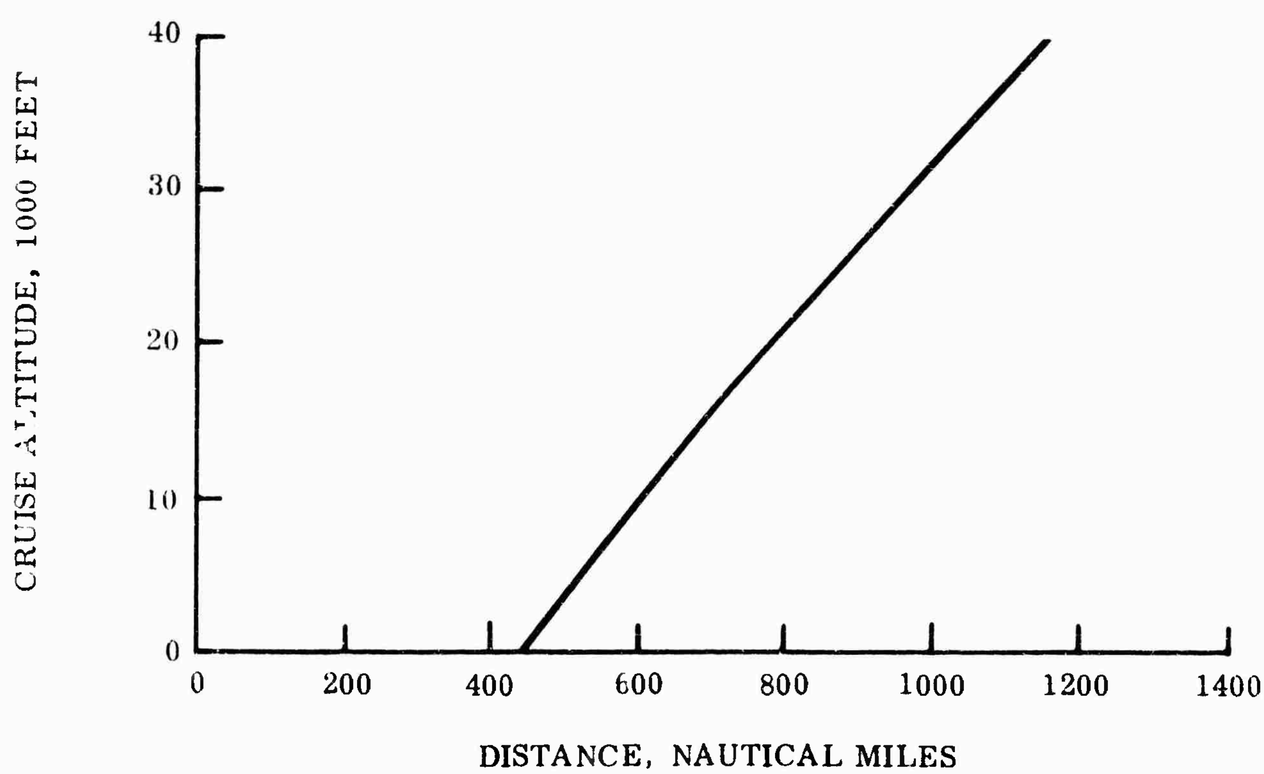


Figure 24 Ferry Distance

GROUP WEIGHT STATEMENT
WEIGHT EMPTY

3.1.3 Weights

1	WING GROUP		1068
2	CENTER SECTION - BASIC STRUCTURE	379	
3	INTERMEDIATE PANEL - BASIC STRUCTURE		
4	OUTER PANEL - BASIC STRUCTURE (INCL. TIPS LBS.)	268	
5			
6	SECONDARY STRUCTURE (INCL. WINGFOLD MECHANISM LBS.)	300	
7	AILERONS (INCL. BALANCE WEIGHT 22.2 LBS.)	51	
8	FLAPS - TRAILING EDGE	70	
9	- LEADING EDGE		
10	SLATS		
11	SPOILERS		
12	SPEED BRAKES		
13			
14			
15	TAIL GROUP		225
16	STABILIZER - BASIC STRUCTURE	73	
17	FINS - BASIC STRUCTURE (INCL. DORSAL LBS.)	95	
18	SECONDARY STRUCTURE (STAB. & FINS)		
19	ELEVATOR (INCL. BALANCE WEIGHT 17.7 LBS.)	36	
20	RUDDERS (INCL. BALANCE WEIGHT 9.0 LBS.)	21	
21			
22			
23	BODY GROUP		1089
24	FUSELAGE OR HULL - BASIC STRUCTURE	761	
25	BOOMS - BASIC STRUCTURE		
26	SECONDARY STRUCTURE - FUSELAGE OR HULL	129	
27	- BOOMS		
28	- SPEEDBRAKES		
29	- DOORS, PANELS & MISC.	199	
30			
31	ALIGHTING GEAR GROUP - LAND (TYPE:)		340

	LOCATION	WHEELS, BRAKES TIRES, TUBES, AIR	STRUCTURE	CONTROLS	TOTAL
32/33					
34	Nose	21	62	19	102
35	Main	68	90	80	238
36					
37					
38					
39					

40 ALIGHTING GEAR GROUP - WATER

41	LOCATION	FLOATS	STRUTS	CONTROLS	
42					
43					
44					
45					

46	SURFACE CONTROLS GROUP		246
47	COCKPIT CONTROLS	34	
48	AUTOMATIC STABILIZATION	35	
49	SYSTEM CONTROLS	83	
50	VERTICAL FLIGHT CONTROLS	94	
51	ENGINE SECTION OR NACELLE GROUP		43
52	INBOARD		
53	CENTER	43	
54	OUTBOARD		
55	DOORS, PANELS & MISC.		
56			
57	TOTAL (TO BE BROUGHT FORWARD)		3011

GROUP WEIGHT STATEMENT
WEIGHT EMPTY

		Auxiliary	Main	
1	PROPULSION GROUP			3460
2		AUXILIARY	MAIN	
3	ENGINE INSTALLATION		926	
4	AFTERBURNERS (IF FURN. SEPARATELY)			
5	ACCESSORY GEAR BOXES & DRIVES			
6	SUPERCHARGERS (FOR TURBO TYPES)			
7	AIR INDUCTION SYSTEM		46	
8	EXHAUST SYSTEM		250	
9	COOLING SYSTEM – ENGINE COMPARTMENT		38	
10	LUBRICATING SYSTEM			
11	TANKS			
12	COOLING INSTALLATION			
13	DUCTS, PLUMBING, ETC.			
14	FUEL SYSTEM		106	
15	TANKS - PROTECTED			
16	- UNPROTECTED			
17	PLUMBING, ETC.			
18	WATER INJECTION SYSTEM			
19	ENGINE CONTROLS		16	
20	STARTING SYSTEM		8	
21	Lift Fan Ducting		108	
22	Lift Fan Installation		1699	
23	Pitch Fan Installation		263	
24	AUXILIARY POWER PLANT GROUP			
25	INSTRUMENTS & NAVIGATIONAL EQUIPMENT GROUP			74
26	HYDRAULIC & PNEUMATIC GROUP			155
27				
28				
29	ELECTRICAL GROUP			172
30				
31				
32	ELECTRONICS GROUP			16
33	EQUIPMENT			
34	INSTALLATION			
35				
36	ARMAMENT GROUP (INCL. GUNFIRE PROTECTION LBS.)			
37	FURNISHINGS & EQUIPMENT GROUP			149
38	ACCOMMODATIONS FOR PERSONNEL (1 LW-2 Seat)		85*	
39	MISCELLANEOUS EQUIPMENT		27	
40	FURNISHINGS			
41	EMERGENCY EQUIPMENT		37	
42				
43	AIR CONDITIONING & ANTI-ICING EQUIPMENT GROUP			17
44	AIR CONDITIONING		11	
45	ANTI-ICING		6	
46				
47	PHOTOGRAPHIC GROUP			
48	AUXILIARY GEAR GROUP			
49	HANDLING GEAR			
50	ARRESTING GEAR			
51	CATAPULTING GEAR			
52	ATO GEAR			
53				
54				
55	MANUFACTURING VARIATION			
56	TOTAL FROM PG. 2			3011
57	WEIGHT EMPTY			7054

* Weight shown is for LW-1 seat until LW-2 seat weight is available.

GROUP WEIGHT STATEMENT
USEFUL LOAD & GROSS WEIGHT

					DESIGN			
1 2	LOAD CONDITION				DESIGN			
3	CREW ( ).)				200			
4	PASSE RS (NO.)							
5	FUEL	Type	Gals.					
6	UNUSABLE	JP-4			45			
7	INTERNAL Tank	JP-4			1586			
8								
9								
10	EXTERNAL							
11								
12	BOMB BAY							
13								
14	OIL							
15	TRAPPED	2 Qts.			3			
16	ENGINE	7 Qts.			12			
17								
18	FUEL TANKS (LOCATION)							
19	WATER INJECTION FLUID (GALS)							
20								
21	BAGGAGE							
22	Flight Test Instrumentation				244			
23	Fan Instrumentation				56			
24	ARMAMENT							
25	GUNS (Location)	Fix. or Flex.	Qty.	Cal.				
26								
27								
28								
29								
30								
31								
32	AMMUNITION							
33								
34								
35								
36								
37								
38								
39	INSTALLATIONS (BOMB, TORPEDO, ROCKET, ETC.)							
*40	BOMB OR TORPEDO RACKS							
41								
42								
43								
44								
45								
46	EQUIPMENT							
47	PYROTECHNICS							
48	PHOTOGRAPHIC							
49								
*50	OXYGEN							
51								
52	MISCELLANEOUS							
53								
54								
55	USEFUL LOAD				2146			
56	WEIGHT EMPTY				7054			
57	GROSS WEIGHT				9200			

*If not specified as weight empty.

3.1.3.1 Alternate Loading. -(Information to be added later).

3.1.4 Center of Gravity Locations. -

Design gross weight (basic flight): 9200 pounds.
Aft LE of MAC 26.4 percent MAC.
Above LE of MAC 8.4 inches.

Most forward center of gravity possible
in flight at gross weight of 9200 pounds.
Aft LE of MAC 25.6 percent.
Above LE of MAC 6.9 inches.

Most rearward center of gravity possible
in flight at gross weight of 7614 pounds.
Aft LE of MAC 30.9 percent.
Above LE of MAC 8.5 inches.

3.1.5 Areas. - (This information is not to be used for inspection purposes).

Wing area total, including ailerons, flaps and 49 square feet of fuselage.	260.321 square feet
Wing flap area, aft of hinge line, total.	25.368 square feet
Aileron area, aft of hinge line, including overhanging external balance forward of hinge, total including 2 square feet of tab area.	22.800 square feet
Horizontal tail area, total.	50.665 square feet
Stabilizer, to elevator hinge, excluding overhanging elevator balance.	38.507 square feet

Elevator, aft of hinge.	12.158 square feet
Vertical Tail area, total.	50.995 square feet
Fin, to rudder hinge, excluding overhanging rudder balance and including contained rudder balance.	45.465 square feet
Rudder, aft of hinge, including 1.2 square feet of overhanging external balance forward of hinge and___square feet of tab area.	5.530 square feet

3.1.6 Dimensions and General Data. - (This information is not to be used for inspection purposes.)

Wings:

Span:	29.833 feet
Chord:	
At root.	145.000 inches
At break of quarter chord line.	109.005 inches
At construction tip (theoretical extended section at tip).	43.000 inches
Mean aerodynamic.	112.919 inches
LE mean aerodynamic (fuselage station).	211.140

Airfoil Section:

Center portion thickness at root 10.55 percent, fan ℄ 12.8 percent, Station 100.75, 13.2 percent.

Outer portion NACA 0012-64 modified. Thickness at tip 12.0 percent.

Incidence:

Butt line 24.00 (approximately wing-fuselage intersection).	-0.110 degrees
Butt line 170.05 (95 percent semi-span)	-3.00 degrees

Sweepback at 25 percent chord:	
Inboard panel.	15.000 degrees
Outboard panel.	28.345 degrees
Dihedral:	
Inboard panel.	0.00 degrees
Outboard panel.	-6.00 degrees
Aspect Ratio:	3.419
Ailerons:	
Span.	76.30 inches
Chord. (average percent chord).	28.85 percent
Tab (both wings), span.	28.93 inches
Tab (both wings), chord, average	4.98 inches
Distance from plane of symmetry to centroid of aileron area.	139.80 inches
Amount of aerodynamic balance	30.80 percent chord
Flaps:	
Type-single slotted.	
Span (percent of wing).	43.0 percent
Chord (average percent of wing).	19.6 percent

Tail.

Horizontal.	
Span.	12.35 feet
Root chord.	65.64 inches
Tip chord.	32.82 inches
Airfoil section NACA 64A012.	
Aerodynamic balance.	25.0 percent
Incidence	(variable)20 degrees LE up, to 5 degrees down
Sweep of LE.	13.7 degrees
Dihedral.	0.0 degrees
Aspect Ratio.	3.010
Elevators:	
Span.	5.542 feet
Root chord.	16.108 inches
Tip chord.	10.221 inches
Balance. - Internally sealed pressure balance	

Vertical:

Airfoil section:		
Water line 113.00 inches NACA 64A016.5.		
Tip (water line 206.00 inches) NACA 64A012		
Sweep of leading edge.	35.0	degrees
Aspect Ratio.	1.178	
Tab:		
Span.	10.0	inches
Chord.	3.5	inches
location - 32.0 inches from rudder root.		
Aerodynamic balance.	34.0	percent
Height over highest point of vertical tail-reference line level.	14.75	feet
Height in hoisting attitude, from top of hoist sling to lowest part of aircraft.	15.0	feet
Length (reference line level).	41.52	feet
Length from hoisting sling to farthest aft point.	23.0	feet
Distance from wing MAC quarter chord point to horizontal tail MAC quarter chord point.	21.13	feet
Distance from wing MAC quarter chord point to vertical tail MAC quarter chord point.	18.25	feet
Angle between reference line and wing zero-lift line.	-0.82	degrees
Ground angle.	21.0	degrees
Wheel size:		
Main wheels.	20 x 4.4	
Nose wheel.	18 x 4.4	
Tire size:		
Main wheels.	20 x 4.4	
Nose wheel.	18 x 4.4	

Tread of main wheels.	100.7 inches @ 9200 lbs. G.W.
Wheel base:	
Normal.	140.4 inches @ 9200 lbs. G.W.
VTOL.	160.4 inches @ 9200 lbs. G.W.
Vertical travel of axles from fully extended to fully compressed:	
Main wheels.	9.0 inches
Nose wheel.	10.0 inches
Distance from main wheel contact point to center of gravity (VTOL position):	
Horizontal distance:	
At most forward CG station 240.0 inches at 9200 pounds gross weight	56.00 inches
At most aft CG station 246.0 inches at 7614 pounds gross weight.	50.00 inches
Vertical distance:	
At most forward CG water line 106.9 inches at 9200 pounds gross weight.	73.90 inches
At most aft CG water line 108.5 inches at 7614 pounds gross weight.	75.50 inches
Distance from main wheel contact point to center of gravity (conventional position):	
Horizontal distance:	
At most forward CG station 240.0 inches at 9200 pounds gross weight.	36.00 inches
At most aft CG station 246.0 inches at 7614 pounds gross weight.	30.00 inches
Vertical distance:	
At most forward CG water line 106.9 inches at 9200 pounds gross weight.	73.90 inches
At most aft CG water line 108.5 inches at 7614 pounds gross weight.	75.50 inches

3.1.7 Control Movement and Corresponding Control Surface Movements. - (The following deflections are variable, and only their maximum limits are shown. This information is not to be used for inspection purposes.)

Rudder 25 degrees right, 25 degrees left.
Rudder pedals 3.25 inches foreward, 3.25 inches aft.
Rudder tab 20 degrees right, 20 degrees left.
Rudder tab control - electrical.
Elevator 25 degrees above, 25 degrees below.
Elevator control 6 inches aft, 6 inches foreward.
Ailerons 22.5 degrees above, 22.5 degrees below.
Aileron control stick 5 inches right, 5 inches left.
Aileron tab right side 22.5 degrees above, 22.5 degrees below.
Aileron tab left side 27.5 degrees above, 27.5 degrees below.
Aileron trim tab control-electrical.
Stabilizer 20 degrees LE up, 5 degrees LE down.
Stabilizer control-electrical.
Wing flap (maximum)45 degrees movement down.
Wing flap control-electrical.

3.2 General Features of Design and Construction. -

3.2.1 General Interior Arrangement. - Refer to Figure 2. The forward fuselage shall contain the nose fan, pilot's compartment, and nose gear. A nose fairing shall be provided foreward of the cockpit and shall contain the pitot mast. The nose fan shall be located directly aft of the fairing and shall be provided with inlet louver closure doors. Thrust director doors, to control the amount of fan lift, shall be installed below the nose fan. The cockpit shall utilize side-by-side seating with the pilot located on the left-hand side of the cockpit. Provisions shall be made for installation of a passenger-observer seat, or data acquisition equipment, on the right-hand side of the cockpit. All primary flight controls shall be routed beneath the cockpit floor. The foreward folding nose gear shall be located directly beneath the cockpit.

3.2.1.1 The center fuselage bay shall contain the avionics group, gas producers, diverter valves, cross ducts, pitch-fan bleed ducts, and one fuel tank. The avionics group shall be installed in a compartment located directly behind the cockpit bulkhead, and shall consist of the auto-stabilization system, electrical system equipment. The foreward fuel tank shall be located directly behind the avionics compartment and shall be an integral type tank with bladder sealing. Engine accessory drive equipment shall be located above the avionics compartment. A separate hydraulic pump, generator, and mechanically driven fan system shall be installed on each side of the aircraft, with each system driven by a separate gas producer. Gas producers and diverter valves

shall be located in the top portion of the center fuselage bay and shall be coupled to the cross-over ducts and conventional-flight tailpipes. A compartment shall be provided immediately below the forward fuel tank, which may be used for equipment, or, an extended range fuel tank. Nose fan gas distribution ducts shall be located in the center fuselage bay immediately inboard of the fuselage skin. Flight controls shall be routed from the center fuselage bay outboard to the wings.

3.2.1.2 The aft fuselage bay shall contain the aft fuel tank, extended range fuel tank, engine tailpipes, main landing gear, and thrust spoiler system. The aft fuel tank shall be located beneath the engine tailpipe shrouds, and behind the cross-over ducts. Conventional-flight tailpipes shall be routed from the aft end of the diverter valves, to the aft fuselage lower section. Tailpipe expansion features shall be provided by a bellows-type flexible joint which couples the diverter valves and tailpipe assemblies. The main landing gear shall be located beneath the aft fuel tank and shall provide for two positions; foreward for CTOL, aft for VTOL. A thrust spoiler system shall be located directly behind the tailpipe nozzles.

3.2.2 Selection of Materials. - ANA Bulletin 143 and other applicable design documents shall be used as a guide in selection and use of materials.

3.2.3 Workmanship. - Workmanship shall be in accordance with highest standard aircraft practices. Special attention shall be given to maximum smoothness and accuracy of exterior surfaces.

3.2.4 Production, Maintenance, and Repair. - Design of the aircraft shall provide for ease of manufacture and maintenance throughout the expected service life. Power plants, fan assemblies, and equipment installations shall be readily removable. The wing, elevators, horizontal stabilizer, ailerons, flaps, and landing gears shall be readily removable. Requirements for special tools shall be held to a minimum.

3.2.5 Interchangeability and Replaceability. - Major assemblies such as wings, tail surfaces, and control surfaces shall be readily replaceable at their attach points.

3.2.6 Finish. - Aircraft components shall be protected from corrosion, and finished in accordance with Ryan finish specification 14359-1 dated 5 July 1962. Exterior aircraft surface shall be polished and unpainted with exception of materials subject to corrosion. Interior of the aircraft shall be finished to insure protection throughout the intended service life of the aircraft.

3.2.7 Identification and Marking. - Aircraft identification and marking shall be in accordance with Specification MIL-P-11747, with exception of deviations required due to unique features of the aircraft.

3.2.8 Extreme Temperature Operation. - The aircraft shall be designed to operate satisfactorily within a ground temperature environment of minus 65° and plus 135° F.

3.2.9 Climatic Requirements. - Since the aircraft is primarily a flight research vehicle, there shall be no provision for climatic requirements other than those listed in paragraph 3.2.8 above.

3.2.10 Lubrication. - Lubrication shall conform to the requirements of Specification MIL-L-6880B.

3.2.11 Equipment and Furnishing Installation. - Equipment and furnishings listed in appendices I-A and I-C of this specification shall be provided and installed, as described in applicable portions of this specification.

3.2.12 Crew. - The crew shall consist of 1 pilot. Provisions shall be made for accommodation of a second crew member located on the right-hand side of the cockpit. The pilot shall have all operational control authority. The second crew member shall be a passenger or observer only.

3.2.13 Noise and Vibration Requirements. - The aircraft and equipment shall function normally in all extremes of noise and vibration encountered in hovering, transition, and forward flight.

3.2.13.1 Vibration. - Design of the aircraft shall insure minimum fatigue repair during the intended service life. Structural repair shall not exceed acceptable levels established for research type aircraft. Analysis of critical areas shall be performed to preclude the possibility of catastrophic fatigue failures occurring within the design life of the aircraft.

3.2.13.2 Crew Comfort. -

3.2.13.2.1 Acoustical Noise. - Insofar as practicable, acoustical noise shall not exceed limits stated in specification MIL-A-8806(ASG).

3.2.13.2.2 Vibration. - Vibration of crew seats, rudder pedals, control columns, and primary structure in crew compartment shall not exceed plus or minus 4 g acceleration at frequencies above 46 CPS. Vibration levels shall not exceed 0.036 inches double amplitude at frequencies of 46 CPS to 15 CPS. Accelerations greater than plus or minus 4 g's shall not be exceeded at frequencies of 15 CPS to 10 CPS. Vibration shall not exceed 0.080 inches double amplitude at frequencies below 10 CPS.

3.2.14 Aircraft Sustained Operation. - The aircraft shall be capable of continued operation subsequent to the flight test program. Design objective service life shall exceed 250 hours.

3.3 Aerodynamics. -

3.3.1 General. - Aircraft design shall maintain smoothness of exterior joints, fairness of surfaces, cleanliness of intersections, and trimness of contours. Fasteners, hinges, access doors, landing gear doors, and fittings shall be flush with exterior where practicable. Protusions shall be limited to those necessary for antennas, scoops, and holes required for venting.

3.3.2 Stability and Control.

3.3.2.1 Requirements. - Stability and control characteristics shall be in accordance with requirements of Ryan Specification 62B062, VZ-11 Flying Qualities, which will be made a part of this specification at a later date. A description of the flight control system is given in paragraph 3.10.

3.3.2.1.1 Stability and control characteristics shall consist of consolidation of handling quality requirements listed in RFQ TREC-RC, Annex C, dated 31 March 1961. In addition to the requirements of Annex C of the RFQ, the following characteristics are recognized as objectives of the Government Contracting Agency and shall be factored into aircraft design to the extent specified by succeeding paragraphs 3.3.2.1.2, 3.3.2.1.3, and 3.3.2.1.4.

Damping and Control Power. - In hovering flight the aircraft pitch and roll control shall be designed to operate within the "desirable" boundary of NASA TN-D-58, Figure 7. At the same flight condition, the yaw control shall provide a control power/inertia ratio of 1 ft lb/inch/slug ft^2 and a damping/inertia ratio of 2 ft lbs/rad/sec/slug ft^2.

Maneuver Velocities. - The hovering flight aircraft controls shall be capable of generating the following terminal angular velocities in response to full stick and pedal deflections:

Pitch	20 degrees/second
Roll	30 " "
Yaw	50 " "

Control Duty Cycles. - One half of roll and yaw control power and all pitch control power shall be available without loss of total combined lift of main fans and nose fan.

3.3.2.1.2 Damping and Control Power. - The control power/inertia ratios of pitch, roll, and yaw controls for full stick and pedal displacement shall meet or exceed the time limited angular displacement requirements of Annex E of the RFQ (MIL-H-8501-A IFR Handling Qualities). In addition, pitch and roll controls shall be designed with the necessary adjustability of damping levels and stick sensitivity to meet "desirable" handling qualities of NASA TND-58, Figure 7. Yaw control shall be designed with the necessary adjustability to meet control power and damping levels specified in paragraph 3.3.2.1.1. Further, all controls shall be adjustable for reduced control power and damping levels to permit general investigation of VTOL handling qualities.

3.3.2.1.3 Maneuvering Velocities. - The roll, pitch and yaw controls shall be designed with the required adjustments and flexibility to meet the minimum full-displacement terminal velocities specified in paragraph 3.3.2.1.1.

3.3.2.1.4 Control Duty Cycles. - The physical maximum control potential from fan exit louvers shall be utilized in the attitude and height control systems. Every effort will be made to meet the control duty cycle specified in paragraph 3.3.2.1.1. It is anticipated that the maximum available control power from lift fans will not meet the combined simultaneous demands of roll pitch and yaw controls without reducing the portion of height control power available from fan exit louver modulation. As an alternative solution, the aircraft controls shall be designed to share available control power in a priority sequency affording optimum combined handling qualities and flight safety.

3.3.2.1.5 Stability Augmentation System. - A stability augmentation system (See Figure 25) shall be provided for use in the fan flight mode to meet requirements specified for attitude stabilization of the aircraft. The system shall consist of pilot controls, system controller, 3-axis gyro package, and amplifier. Two channels; a primary channel (with variable gain features), and a secondary channel acting as stand-by shall be provided.

3.3.2.1.5.1 Aircraft stabilization shall be accomplished by using 3-axis rate gyro signals coupled to hydraulic actuators. Actuator position shall control the wing-fan exit louvers and pitch-fan thrust modulators. In addition to angular rate response, angular position signals shall be provided by electronic integrator networks. In flight, both primary and stand-by channels shall be energized with provisions for pilot selection of either channel.

3.3.2.5.2 System operation shall provide two modes; a holding mode, and a maneuvering mode. In the holding mode, $\frac{\beta s}{s\phi} = K\frac{T_r s + 1}{10s + 1}$ is the overall system transfer function and provides: degrees of louver stagger-angle per fan/degree/second. Gain (K) shall be variable from 0 to 10. The ratio $T_r/10$ shall be adjustable for six preset values of 0.002, 0.01, 0.02, 0.03, 0.05 and 0.10. Gain and ratio adjustment shall be provided in the primary channel only.

3.3.2.1.5.3 In the maneuvering mode, the integrating networks shall be shorted to eliminate position feedback control signals. The overall system transfer function then becomes $\frac{\beta s}{s\phi} = K'$ providing degrees of louver stagger-angle per fan/degree/second. Gain (K') shall be variable from 0 to 3. Switches in the primary control mixing box shall be used to short the integrating networks, and provide gain control switching. Simultaneous roll and yaw control of the wing-fan exit louvers shall be accomplished by bridge connection of the louver actuators.

3.3.2.1.6 Attitude Control. - All attitude control powers in the hover mode shall be derived entirely from the main engines, making maximum use of inherent functional control capability of the lift-fan system. In event of power loss of either engine, attitude control capability shall not preclude execution of a safe landing.

3.3.2.1.7 Control Requirements, Conventional Flight Mode. - The aircraft shall meet primary stability requirements of RFQ TREC-RC, Annex E, and Ryan Specification 62B062, VZ-11 Flying Qualities, without the use of a stability augmentation system.

3.3.2.1.8 Conversion Between Lift-Fan and Conventional Flight Mode. - The pilot shall not be required to remove his hands from the primary controls to accomplish conversion between VTOL and conventional modes of operation. Control transients shall be minimized by proper coordination of longitudinal trim during lift-fan starting or shut-down, and by requiring a minimum power change when shifting between the two modes of operation.

3.3.2.2 Center of Gravity Limits. - See paragraph 3.1.4. and Figure 27. In general, the aircraft center of gravity limits shall be as follows:

(a) Aft limit, Station 246.0
(b) Forward limit, Station 240.0

3.3.2.2.1 The above limits represent the most aft limit from aircraft conventional flight stability consideration, and the most forward limit from hovering trim considerations.

3.3.3 Flutter Characteristics. - The aircraft shall be free from divergence, flutter, buzz, or other aeroelastic instability throughout its range of design speeds, altitudes, maneuvers, and loading and weight conditions. Flutter requirements shall be determined using specification MIL-A-8870 as a guide.

3.4 Structural Design Criteria. - Structural design of the aircraft shall be derived from the requirements of specification MIL-A-8860 and Ryan structural criteria report, 62B094. Allowable stress values shall be in accordance with MIL Handbook-5.

3.4.1 Limit Flight Load Factors. - Aircraft design shall be based on flight load factors produced by pull-up/push-over maneuvers, and vertical gusts. Design strength, for weights greater than basic flight design gross weight, shall be provided by a constant load factor times weight ratio.

3.4.1.1 Minimum Flying Gross Weight - 7693 pounds.

Maneuver:	Positive 4.00	Negative 2.00
Gust:	Positive 4.00	Negative 2.00

3.4.1.2 Basic Flight Design Gross Weight. - 9200 pounds

Maneuver:	Positive 4.00	Negative 2.00
Gust:	Positive 4.00	Negative 2.00

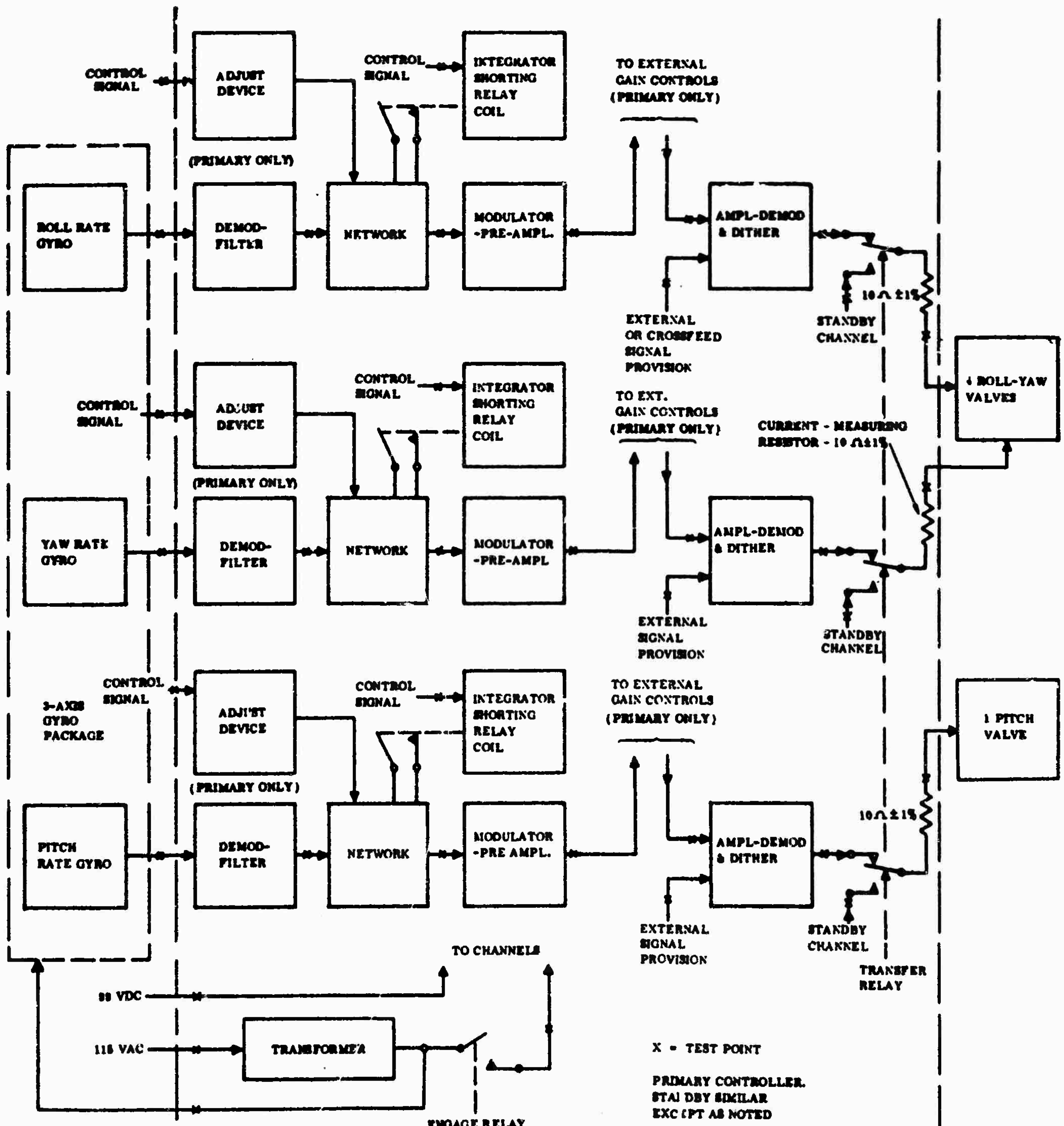


Figure 25 Automatic Stabilization System Block Diagram

3.4.1.3 Maximum Design Gross Weight. - 12,500 pounds.

Maneuver:	Positive 2.94	Negative 1.47
Gust:	Positive 2.94	Negative 1.47

3.4.2 Landing Load Factors. - The aircraft shall be designed for conventional and vertical landings. Design loads shall provide for conventional landing (basic landplane gross weight) with the main gear in forward position.

3.4.2.1 Basic Landplane Gross Weight. - 9200 pounds.

		CTOL	VTOL
Sinking Speed:	Gear forward	10 feet per second	————
	Gear aft	6 feet per second	10 feet per second

3.4.2.2 Maximum Landing Gross Weight. - 12,500 pounds.

Sinking Speed: 6 feet per second

3.4.3 Design Speeds. - See Figure 26.

3.4.4 Center of Gravity Limits. - See Figure 27.

3.4.5 Structural Design Service Life. - Structural integrity shall be preserved for a minimum service life of 250 hours distributed at the following flight speeds:

(a) 150 hours at 140 percent stall speed or below.
(b) 75 hours at speed for best cruise.
(c) 25 hours at level flight maximum speed.

3.5 Wing Group. -

3.5.1 Description and Components. - The wing shall be a mid-wing monoplane configuration. Each half span shall consist of an inner panel, housing the lift fan and trailing edge flap, and an outer panel containing the aileron and wing tip. A wing fan inlet closure system consisting of a butterfly type door shall be provided. The doors shall be hinged along the strut fairing of the lift fan in the chord-wise direction. In fan operation, the doors shall open back-to-back through the use of hydraulic actuators.

Exit louvers under the fan shall provide an exit closure system. A cooling fan shall be located aft and outboard of each wing fan. The fan shall direct cooling air toward the inboard portion of the wing, thereby circulating warm air in the wing fan vicinity, and providing cooling of the wing spars.

3.5.2 Construction. - Wing structure shall utilize two half span spars connected to the fuselage inter-spar structure. Multiple rib-type construction shall be used for skin stiffening and load carrying. A main rib, outboard of the lift fan, shall be utilized to distribute loads from the outboard wing panel to the inboard wing panel. Wing loads shall be carried from the stiffened skin, to the ribs, and beamed into the forward and aft spars. The wing spars are connected to the inter-spar structure in the fuselage and transmit wing reaction loads into bulkheads located at each spar. Wing torsion is transmitted to the fuselage anddistributed into the bulkheads through differential spar bending. Shear loads are handled by fuselage skin panels. Wing fan loads are distributed to the wing at three locations. The primary fan mount is located at the forward spar on the chord center line of the fan and accepts reaction loads in all directions from the fan. The aft fan mount is attached to the aft wing spar and accepts vertical and lateral reactions. A third mount is located at the span-wise center line in the fuselage and reacts to vertical, forward, and aft loads.

3.5.2.1 Wing materials shall be aluminum, magnesium, and fiberglass. Inboard wing skins, and all wing spars, shall be made of aluminum alloy. Outboard wing panel skins shall be made of magnesium alloy. The wing tip shall be made of reinforced Fiberglas.

3.5.3 Ailerons. - Ailerons shall be single spar, ribbed construction made with aluminum alloy. All skins shall be magnesium. Static balance weights made of tungsten shall be provided. An aerodynamic balance seal shall be attached to the leading edge of the aileron and spar. Provision shall be made for aileron trim.

3.5.4 Lift and Drag Devices. - Single-slotted flaps shall be installed on the inboard trailing edge of each wing. Flaps shall be single spar construction made from aluminum and or titanium alloy.

DESIGN SPEEDS
ARDC STANDARD DAY

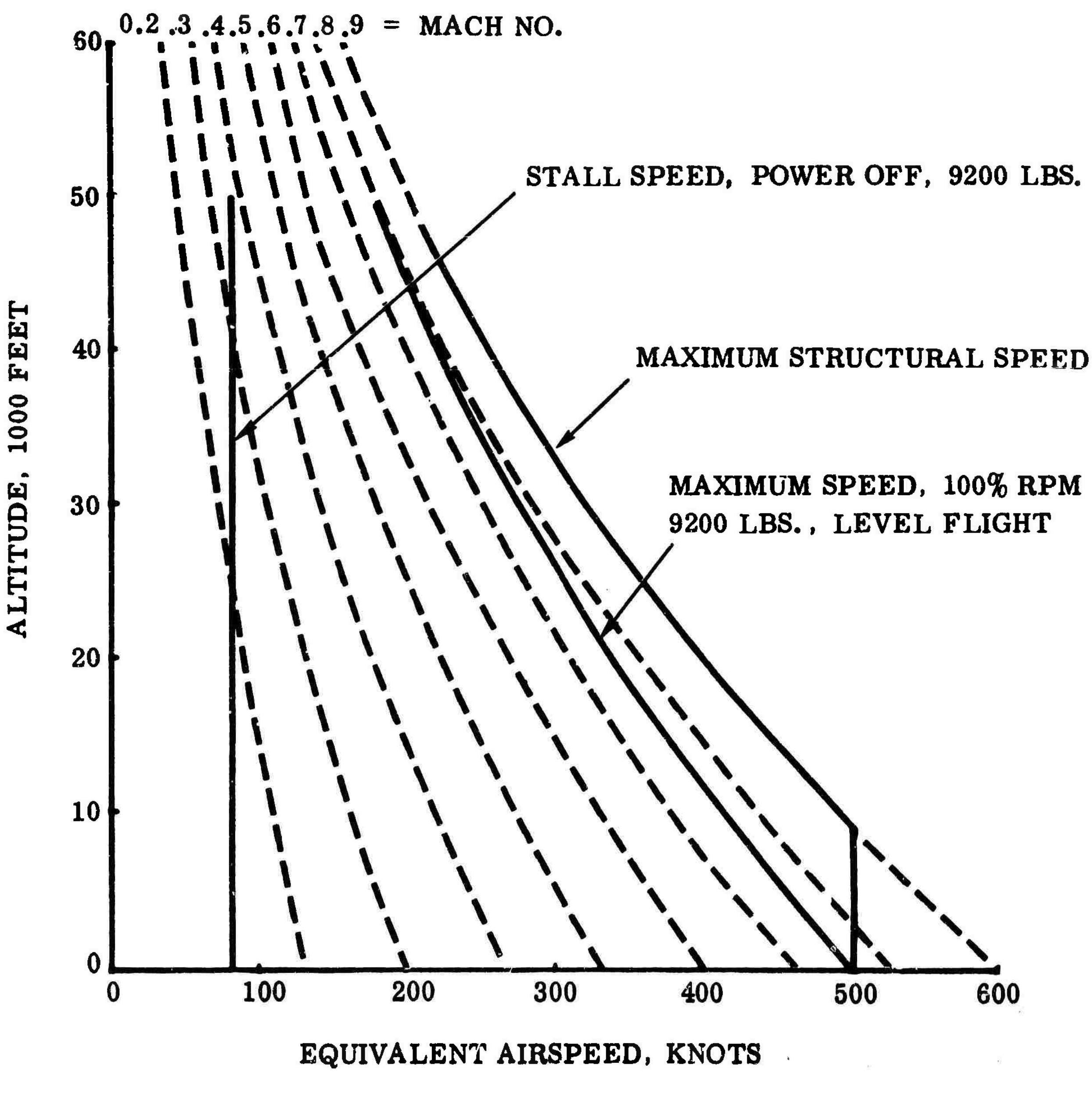


Figure 26 Design Speeds

CENTER OF GRAVITY LIMITS

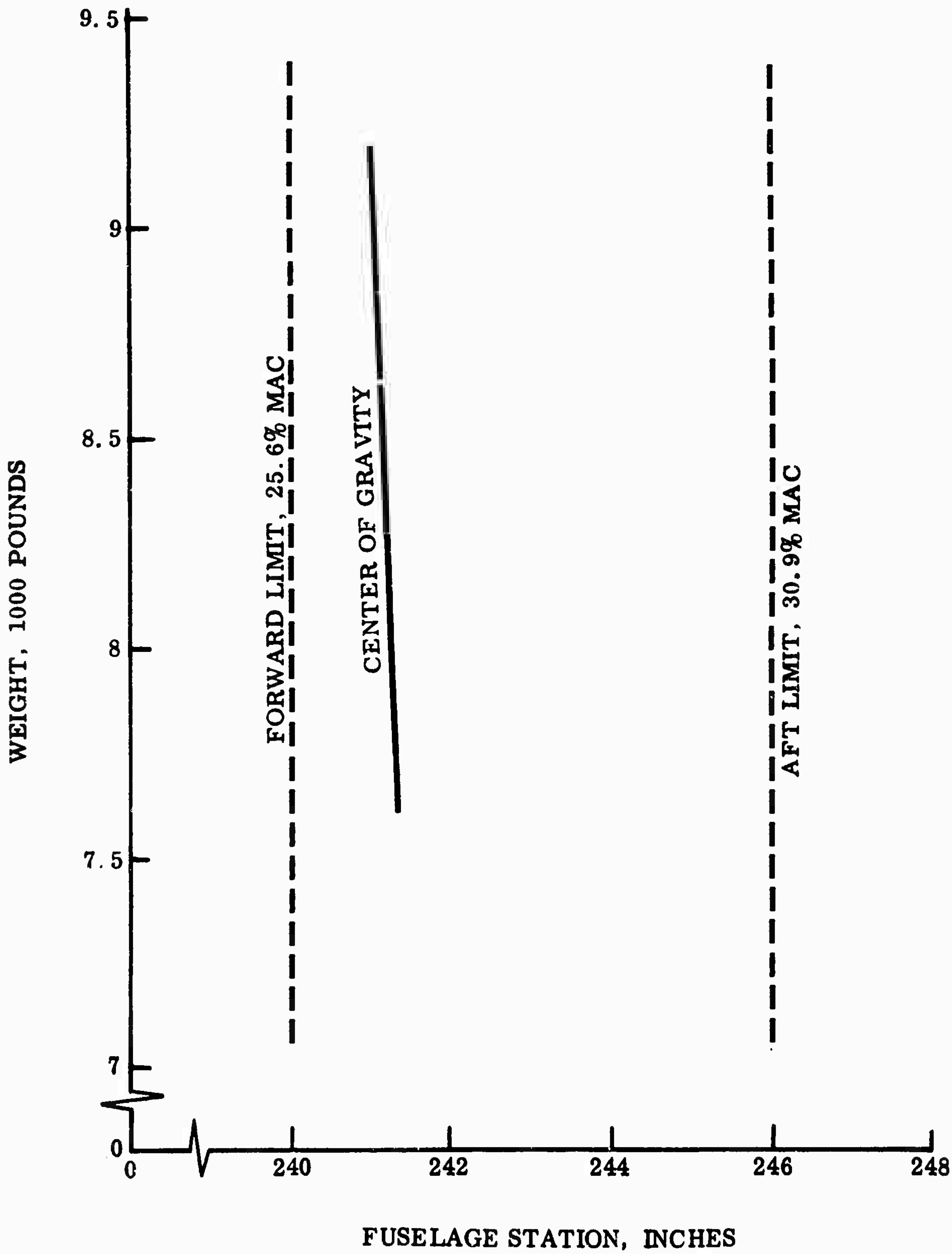


Figure 27 Center of Gravity Limits

3.6 Tail Group. -

3.6.1 Description and Components. - The tail group shall be a "tee" configuration consisting of horizontal stabilizer, elevator, vertical fin, rudder, and rudder trim tab.

3.6.2 Stabilizer. - The horizontal stabilizer shall be an all-movable configuration and shall be located at the top of the vertical fin. Construction shall consist of ribs and skin attached to spars. The primary spar is attached to the vertical fin at two mounting points. The stabilizer actuator attaches to the forward spar, providing three mounting points. Stabilizer spars and ribs shall be made of aluminum alloy covered with magnesium alloy skins.

3.6.3 Elevators. - Elevators shall be single spar, honeycomb construction. Material shall be aluminum alloy with 5052 aluminum alloy core. The elevator shall be hinged at the horizontal stabilizer aft spar and actuated by conventional bellcrank system.

3.6.4 Fin. - The vertical fin shall consist of three-spar construction with conventional ribs and skin. The rear spar shall provide support for the rudder. The three spars shall form a torque box and serve to support the stabilizer attachment fittings. Spars and ribs shall be aluminum alloy. Skins shall be magnesium.

3.6.5 Rudder. - The rudder shall be single spar construction with conventional ribs. Spar and ribs shall be made of aluminum alloy. Magnesium alloy skins shall be used. The rudder shall contain a directional trim tab located on the trailing edge.

3.7 Body Group. -

3.7.1 Fuselage. -

3.7.1.1 Description. - The fuselage shall provide for a pitch fan and thrust modulating mechanism, located in the forward portion of the fuselage. The pilot's compartment shall be located aft of the pitch fan and accommodate 1 pilot and 1 passenger or observer. The nose alighting gear shall be located beneath the pilot's compartment and retract forward. An integral fuel tank shall be installed in the area behind the cockpit. The gas producers and diverter valves shall be located above the wing in the top portion of the fuselage. The center bay of the fuselage shall accommodate the avionics equipment, cross-over ducts, fuel tank and pitch fan bleed ducts. The aft bay of the fuselage shall accommodate a fuel tank, engine exhaust pipes, and main landing gear. Heat shielding and firewalls shall be provided to protect equipment and personnel from bleed duct and power plant heat dissipation.

3.7.1.2 Construction. - The fuselage shall be semi-monocoque construction with exception of the center bay which shall be space frame construction incorporating non-structural access panels. Space frame structure shall act as the primary load carrying system between the forward and aft spar bulkheads. The space frame shall also serve as a power plant and cross-over duct mounting. The aft fuselage shall consist of a three-longeron system on each side of the fuselage. Three aft fuselage frames shall be connected to the vertical fin spars. A bulkhead shall be provided to distribute landing loads in the fuselage. The fuselage shall be constructed of aluminum alloy. Skin areas carrying light structural loads shall be made of magnesium alloy. The forward fuselage fairing shall be reinforced Fiberglas.

3.7.1.3 Crew Station Subsystems. - The crew station shall be located in the forward fuselage section behind the nose pitch fan. Side-by-side seating shall be provided for pilot and passenger. A North American LW-2 ejection escape system shall be provided for the crew. The pilot shall be located on the left side of the cockpit and have complete operational authority. Figure 28 illustrates the preliminary instrument panel arrangement. The right-hand station shall be provisioned for an observer or flight data acquisition system. Instrumentation shall be provided for VFR conditions. Crew station access shall be gained through a manually operated canopy, hinged at the aft end. The canopy shall be designed for removal under emergency egress conditions and for through-the-canopy ejection at low altitudes.

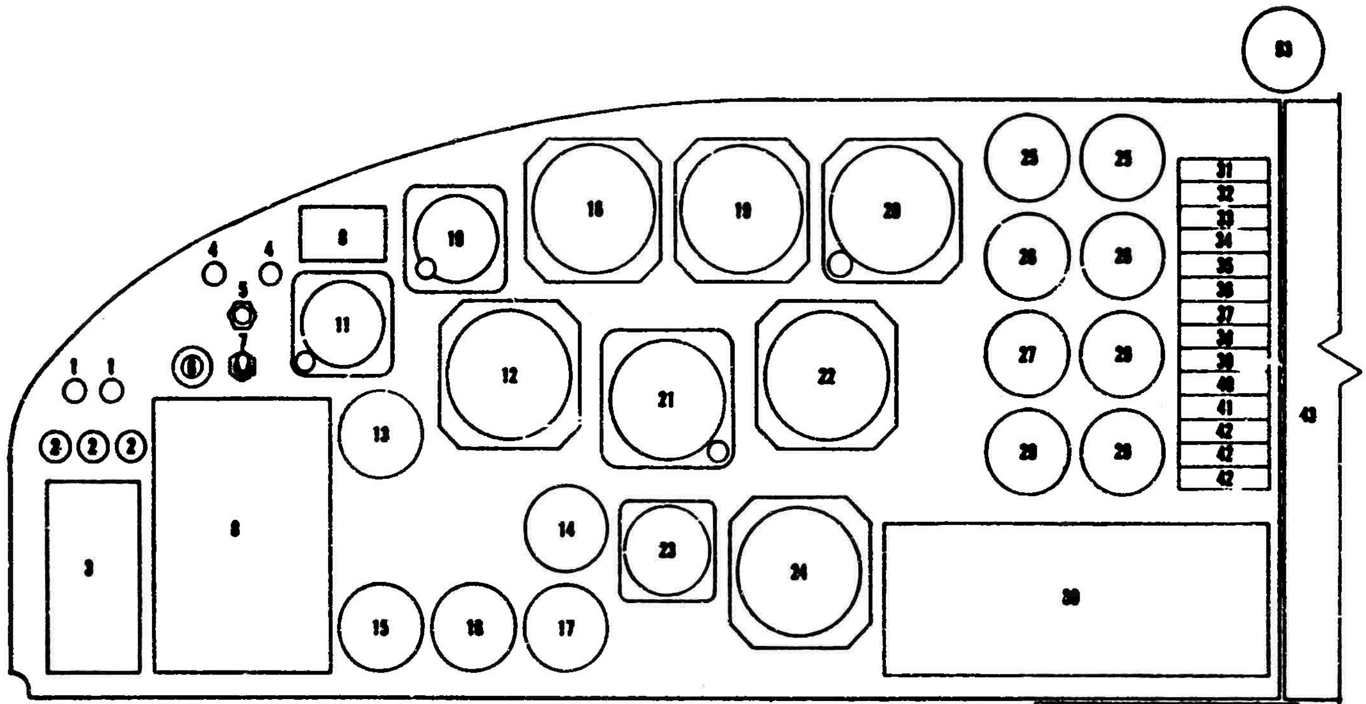
3.7.1.3.1 Oxygen System. - A gaseous oxygen breathing system shall be installed as part of the seat system, and shall be for emergency use only.

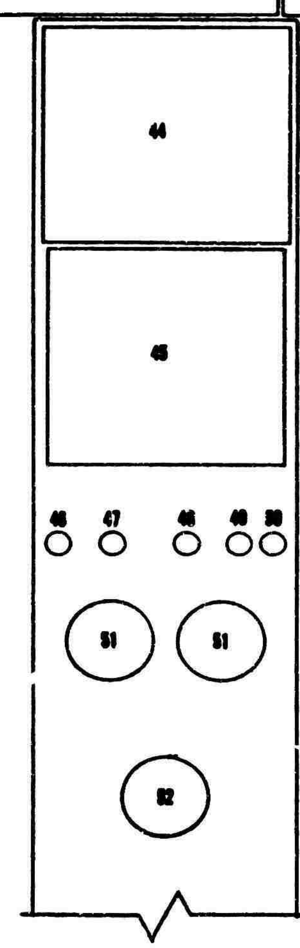
3.7.1.4 Cargo Compartments. - Not applicable.

3.7.1.5 Equipment Compartments. - A readily accessible equipment compartment shall be provided in the fuselage aft of the cockpit bulkhead. Additional compartment space shall be provided in the lower fuselage bay, and between the pitch fan bleed ducts. Compartment space in the lower fuselage bay (presently housing extended range fuel tanks), may be used for additional stores.

3.8 Alighting Gear. -

3.8.1 General Description and Components. - Alighting gear shall consist of main landing gear and nose landing gear. Both gears shall be completely retractable into the fuselage. Mechanical down and up locks with cockpit indication shall be provided.





1. LANDING GEAR MODE INDICATORS
2. LANDING GEAR POSITION INDICATORS
3. LANDING GEAR CONTROL
4. ENGINE OVERHEAT AND FIRE WARNING INDICATORS
5. ENGINE FIRE SELECT SWITCH
6. EXTINGUISHING AGENT RELEASE SWITCH
7. EXTINGUISHING AGENT SELECT SWITCH
8. AUTO STABILIZATION SYSTEM PANEL
9. MASTER CAUTION INDICATOR
10. ACCELEROMETER
11. CLOCK
12. ANGLE OF ATTACK INDICATOR
13. FLAP AND THRUST SPOILER POSITION INDICATOR
14. WING FAN VECTOR ANGLE INDICATOR
15. LEFT WING FAN RPM INDICATOR
16. PITCH FAN RPM INDICATOR
17. RIGHT WING FAN RPM INDICATOR
18. RATE OF CLIMB INDICATOR
19. AIRSPEED INDICATOR
20. ALTIMETER
21. ATTITUDE INDICATOR
22. ANGLE OF YAW INDICATOR
23. TURN AND BANK INDICATOR
24. RUDDER, AILERON, AND HORIZONTAL STABILIZER TRIM INDICATOR
25. ENGINE RPM INDICATORS
26. EXHAUST GAS TEMPERATURE GAUGES
27. DUAL OIL PRESSURE GAUGE
28. DUAL FUEL QUANTITY GAUGE
29. FUEL FLOW GAUGES
30. FLIGHT MODE PANEL
31. NO. 1 GENERATOR OFF LIGHT
32. NO. 2 GENERATOR OFF LIGHT
33. PRIMARY INVERTER CUTOUT LIGHT
34. SECONDARY INVERTER OFF LIGHT
35. PRIMARY INVERTER REGULATION LIGHT
36. FOREWARD FUEL TANK LOW LIGHT
37. AFT FUEL TANK LOW LIGHT
38. NO. 1 ENGINE FIRE LIGHT
39. NO. 2 ENGINE FIRE LIGHT
40. LANDING GEAR UNSAFE LIGHT
41. AUTO STABILIZATION SYSTEM FAILURE LIGHT
42. SPARES
43. BLANK PANEL
44. FUEL MANAGEMENT PANEL
45. VHF RADIO
46. BATTERY INDICATOR
47. NO. 1 GENERATOR INDICATOR
48. NO. 2 GENERATOR INDICATOR
49. PRIMARY INVERTER INDICATOR
50. SECONDARY INVERTER INDICATOR
51. VOLTMETER/AMMETERS
52. HYDRAULIC PRESSURE GAUGE
53. COMPASS

NOTE: THIS INSTRUMENT PANEL ARRANGEMENT IS PRELIMINARY AND SUBJECT TO CHANGE UP TO THE TIME OF MOCKUP REVIEW.

Figure 28 Preliminary Instrument Panel Arrangement

3.8.2 Main Landing Gear. -

3.8.2.1 Description. - Each main landing gear shall consist of a vertical acting shock strut, supporting structure and wheel and brake assembly. The gear shall pivot about a trunnion rigidly attached to the fuselage bulkhead. The landing gear assembly shall have provisions for two positions. The forward position shall be for conventional flight and STOL; the aft position shall be for VTOL flight operations. Retraction and extension shall be accomplished hydraulically.

3.8.2.2 Wheels, Brakes, and Brake Control Systems. - The main landing gear wheel shall be 20 by 4.4 in accordance with specification MIL-W-5013E. Each wheel shall be capable of rolling under design gross weight conditions a minimum of ______ miles. The braking system shall be capable of at least ____ stops at ____ feet per second deceleration. Toe-operated pedals shall be provided for brake operation. Braking locks shall not be provided.

3.8.2.3 Casing and Tubes. - Each of the main gear installations shall be provided with one 20 x 4.4 by 12 PR nylon type, high pressure, tubeless tire. Tires shall comply with specification MIL-C-5041B.

3.8.2.4 Shock Absorbers. - The main landing gear strut shall be designed in accordance with specification MIL-S-8552A. Each strut shall be capable of absorbing the shock of a 10 FPS velocity vertical landing at design gross weight in the hover mode, and 10 FPS velocity in the conventional flight mode, at basic design gross weight.

3.8.2.5 Retracting, Extending, and Locking Systems. - Gear retraction and extension shall be accomplished hydraulically by a folding set of drag links that mechanically lock the gear in the extended or retracted positions. Emergency provisions shall be made to lower the gear in event of hydraulic system pressure loss.

3.8.2.6 Doors and Fairings. - Wheel and doors shall be mechanically actuated and shall close only when the gear is retracted. ?

3.8.2.7 Inspection and Maintenance. - Provisions for inspection and maintenance of the installed main landing gear shall be included.

3.8.3 Auxiliary Landing Gear (Tail Wheel). - Not applicable.

3.8.4 Auxiliary Landing Gear (Nose Wheel). -

3.8.4.1 Description. - The nose gear assembly shall consist of a shock strut with single fork-type axle and wheel assembly. The gear assembly shall be attached to the fuselage structure with trunnion fittings. The gear assembly shall lock in the extended or retracted positions. Emergency provisions shall be incorporated for gear extension in case of hydraulic system pressure loss. A nose wheel shimmy damper shall be provided. Steerable nose wheel provisions shall not be included. Additional description of the nose gear assembly will be provided later.

3.8.4.2 Wheels. - The nose landing gear wheel shall be 18 x 4.4 and shall comply with specification MIL-W-5013E. The wheel shall be capable of rolling under maximum forward CG conditions for a minimum of 1000 miles.

3.8.4.3 Casings and Tubes. - The nose gear installation shall be provided with one 18 x 4.4 by 10 PR nylon, type VII, high pressure, tubeless tire in accordance with specification MIL-C-5041B.

3.8.4.4 Shock Absorbers. - The nose gear shock strut shall be designed in accordance with specification MIL-S-8552A.

3.8.4.5 Retracting, Extending, and Locking Systems. - Nose gear extension and retraction shall be accomplished hydraulically by a folding set of drag links which lock the gear in the extended or retracted position. Positive lock provisions shall be included in event of hydraulic pressure loss. Emergency extension provisions shall be included.

3.8.4.6 Doors and Fairings. - Wheel doors shall be mechanically linked to landing gear operation.

3.8.4.7 Steering Control. - Nose wheel steering shall not be provided.

3.8.4.8 Inspection and Maintenance. - Provisions shall be included for inspection and maintenance of the installed nose gear assembly.

3.9 Alighting Gear (Water Type). - Not applicable.

3.10 Flight Control System. -

3.10.1 Primary Flight Control Systems. - The primary flight control system shall consist of conventional stick and rudder pedals mechanically connected to aerodynamic flap-type control surfaces, wing-fan exit louvers, and nose-fan thrust modulator hydraulic servo valves. Wing-fan exit louvers and nose-fan thrust modulators shall be hydraulically actuated. Actuation of wing-fan louvers shall be accomplished using two actuators per fan (1 forward, 1 aft) to perform both vector and stagger functions, using an even-odd louver actuation scheme. Nose-fan thrust modulation shall be accomplished with one actuator. All actuator servo valves shall have electrical input features capable of accepting actuator position input signals from the stability augmentation system amplifiers. The servo system shall be powered by two separate engine driven hydraulic systems. All hydraulic actuators shall be dual tandem types. Stick and rudder pedals shall perform identical attitude control functions in the conventional and fan flight modes. A collective lift control shall be provided for altitude control in the fan flight mode. The collective lift control shall adjust wing-fan exit louver stagger, and nose-fan thrust modulator. Lateral stick motion shall control ailerons and differential stagger of wing-fan exit louvers. Longitudinal stick motion shall control elevators and nose-fan thrust modulators. Rudder pedals shall control the rudder and differential vector of the wing-fan exit louvers, and also the wheel brakes. A mechanical mixer mechanism shall be installed in series with the cockpit controls and louver actuator servo valves. The mixer shall be capable of interpreting pilot commands in positioning of the wing-fan exit louvers. The mixer shall provide a wing-fan control system disengagement feature for operation in the conventional flight mode. A similar device shall disengage the nose-fan thrust modulators. Devices shall be provided for trimming of the fan and aerodynamic control systems in flight.

3.10.1.1 Flight Station Controls. - All flight controls shall be arranged within the cockpit to provide maximum utility for flight evaluation of the aircraft, and comfort to the pilot. The flight controls, their functions, and locations are listed in Table 2.

Cockpit Control	Fan Mode	Conventional Mode	Cockpit Location
Longitudinal stick (Pitch)	Controls nose fan thrust modulator	Positions elevator	center cockpit
Lateral stick (Roll)	Controls differential wing-fan exit louver stagger	Positions ailerons	Forward cockpit
Rudder Pedals (Yaw)	Controls differential wing-fan exit louver vectoring	Positions rudder	Forward cockpit
Collective Lift (altitude)	Controls collective wing-fan exit louver stagger and nose fan thrust modulator	Inoperative	Left side adjacent to seat
Power Levers	Operative as in conventional mode	Control gas generator speeds independently	Left side console
Collective Power	Control gas generator speeds collectively	Operative as in fan flight mode	Twist grip on collective lift control
Mode Selector	Commands conversion to conventional flight	Commands conversion to fan flight mode	Thumb switch on collective lift control
Exit louver vector selector	Commands exit louver deflection, zero to 50°	Inoperative	Thumb switch on top of longitudinal stick
Flap, thrust spoiler, louver control (FTSLC)	Operative as in conventional mode with louver command function removed	Authority for simultaneous command of flap deflection, thrust spoiler, nose fan inlet louvers and wing fan exit louvers (between closed and 50°)	Console, left side of cockpit

Table 2 Flight Control Functions and Locations

Cockpit Control	Fan Mode	Conventional Mode	Cockpit Location
Thrust spoiler control	Operative as in conventional	Commands thrust spoiler position and removes thrust spoiler command function from the FTSLC	Switch on console on left side of cockpit
Exit louver control	Inoperative	Commands nose fan inlet and wing fan exit louver position and removes louver control authority from the FTSLC	Switch on console on left side of cockpit
Hovering roll-pitch trim	Adjusts centering devices for position of the stick for zero force in hovering	Inoperative	Right-left, forward-aft switch on top of stick
Hovering yaw trim	Adjusts centering devices for position of the rudder pedals for zero force in hovering	Inoperative	Right-left switch on top of stick
Conventional pitch trim	Operative as in conventional mode	Positions horizontal stabilizer	Forward-aft switch on top of stick
Conventional roll trim	Operative as in conventional flight	Adjusts aileron trim tab	Switch on console on left side of cockpit
Conventional yaw trim	Operative as in conventional flight	Adjusts rudder trim tab	Switch on console on left side of cockpit
Power reset	Commands return to original gas generator power setting following automatic cutback as a result of fan overspeed	Inoperative	Thumb switch on collective lift control

Table 2 Flight Control Functions and Locations (Continued)

3.10.1.2 Lateral System. - The lateral (roll) system shall utilize ailerons, and differential stagger of the wing-fan exit louver system. Aileron actuation shall be accomplished using a cable system with a tension regulating cable drum. Differential stagger shall be controlled by a hydraulic servo system. The system shall be actuated by the pilot through the use of push rods and bellcranks. Pilot commands shall pass through a mechanical mixing mechanism yielding a control signal to the forward and aft louver actuators. Ailerons shall incorporate mass balance with aerodynamic balancing accomplished by adjustable geared trailing edge tabs. In the fan flight mode, a stick force gradient with stick centering shall be provided. In conventional flight mode, fan mode control is disengaged at the mixer.

3.10.1.3 Directional System. - The directional (yaw) system shall utilize a rudder and differential vector of the wing fan exit louver system. Rudder actuation shall be accomplished using a push-rod cable system with a tension regulating cable drum. Differential vector shall be controlled by a hydraulic servo system. The system shall be mechanically actuated by the pilot through the use of push rods and bellcranks. Pilot commands shall pass through a mechanical mixing mechanism yielding a control signal to the forward and aft louver actuators. The rudder shall incorporate mass balance with hinge moment balance accomplished by an adjustable geared trailing edge tab. In the fan flight mode, a rudder force gradient shall be provided. In conventional flight mode, fan mode control is disengaged at the mixer.

3.10.1.4 Longitudinal System. - The longitudinal (pitch) system shall utilize an elevator and nose-fan thrust modulation mechanism. Elevator actuation shall be accomplished using a push-rod cable system with a tension regulating cable drum. The nose fan thrust modulator shall be controlled by a hydraulic servo system. The system shall be mechanically actuated by the pilot through the use of a push-rod and bellcrank system. Pilot inputs shall pass through a mechanical mixing mechanism which sums the pitch and collective stagger altitude control commands. The elevator shall incorporate mass balance. In fan flight mode, an elevator force gradient with stick centering shall be provided. For conventional flight, fan mode control is disengaged at the mixer.

3.10.1.5 Lift System. - The lift (altitude) system shall utilize collective stagger of the wing fan exit louver system and the nose-fan thrust modulator mechanism. Control shall be accomplished by a hydraulic servo system. The system shall be mechanically actuated by the pilot through the use of push-rods and bellcranks connected to servo valves. Pilot commands shall pass through a mechanical mixing mechanism yielding control signals to the wing fan louver actuators and the nose-fan modulator actuators. In the conventional flight mode, the lift control system is disengaged at the mixer. The collective lift control shall be irreversible.

3.10.2 Secondary Flight Control Systems. -

3.10.2.1 Lift and Drag Increasing Device Systems. - Single-slotted flaps shall be incorporated, and controlled by pilot command. Flaps shall be interlocked to prevent selection of VTOL and STOL flight modes unless they are in the full down position. The flaps shall have provisions for positioning at intermediate points during conventional flight. A cockpit indicator shall be provided for flap position information. A thrust spoiler device shall be included to permit high gas producer output with low foreward thrust component, to reduce fan spin-up time.

3.10.2.2 Speed Brakes. - Not applicable.

3.10.3 Trim Control Systems. - Lateral and directional aerodynamic trim shall be accomplished by use of electrical screw jacks located in the geared tab system. Longitudinal aerodynamic trim shall be accomplished by an electrically driven screw jack attached to the horizontal stabilizer. Hovering flight trim shall be accomplished by adjustment of stick and rudder pedal positions for zero forces. Automatic trim for transition shall be accomplished by programming horizontal stabilizer and nose fan thrust modulator positions as a function of exit louver position.

3.10.4 Automatic Flight Control System. - Automatic flight control shall not be provided. A stability augmentation system shall be provided for fan supported flight.

3.11 Engine Section or Nacelle Group. -

3.11.1 Description and Components. - Two General Electric J-85-5 turbojet engines with diverter valves shall be located above the wing, and aft of the crew station. The engines shall be mounted side-by-side in a common nacelle isolated by vertical and horizontal firewalls. The engines shall have a common induction inlet with an internal flow splitter. The inlet is located above and aft of the canopy. Engine access doors shall be removable to permit simultaneous servicing of the engines. Engine induction inlets shall be removable for servicing engine controls.

3.11.2 Construction. - The engine access panels shall be an integral part of the fuselage structure but shall not contain any primary load-carrying structures. Material shall be aluminum alloy with exception of the firewalls. Air induction inlets shall be made of reinforced Fiberglas and shall incorporate anti-icing provisions.

3.11.3 Engine Mounts. - The engine mounting system shall consist of master mounts at the diverter valves, and a vertical mount at the forward end of the engines. Side mounts shall be provided at the lower, forward section of the diverter valves.

3.11.3.1 The wing fan mounting system shall consist of three mounts for each fan. A forward master mount attached to the forward wing spar shall be provided. This mount shall be a ball and socket type capable of accepting reaction loads in all directions. An inboard side mount shall be provided at the span-wise center line of the fuselage. This mount shall be capable of accepting reaction loads in the vertical, fore, and aft planes. An aft fan mount shall be provided and attached to the aft wing spar. This mount shall be capable of accepting reaction loads in the vertical and lateral planes. The fan-surrounding wing structure shall terminate in a circular seal of flexible material. The seal shall attach to the wing structure and fan frame, sealing the wing surface and permitting fan movement relative to the wing.

3.11.3.2 The pitch fan mounting system shall consist of a master mount located at the aft section of the fan and attached to a cantilever trussed structure. Two side fan mounts shall be provided and attached to fuselage longerons. One side mount shall be capable of accepting vertical and fore and aft loads only. The other side mount shall accept vertical loads only. The master mount shall accept loads in all three directions.

3.11.3.3 The cross duct mounting system shall consist of a master mount on the outboard side of the duct which will accept loads in any direction, a second mount on the inboard side of the cross duct that accepts vertical and fore and aft loads but allows lateral thermal growth and a third stabilizing tension link connecting one leg of the duct with the inboard lift fan mount. Each of the two cross ducts shall be independently mounted and isolated from adjoining powerplant components by bellows sections.

3.11.4 Vibration Isolators. - Vibration isolators shall not be required.

3.11.5 Firewalls. - Engine compartment fron ttom, and aft end shall incorporate fire isolation provisions. The engine compartment shall be sealed at the forward and aft ends by vertical titanium firewalls. A horizontal firewall shall seal the bottom of the engine compartment. This firewall shall be made of titanium and shall contain holes to accomodate the diverter valves and engine starter lines. Finger seals shall be used to seal holes around the diverter valves and engine starter lines. The engines shall be isolated from each other by a vertical titanium firewall that runs the length of the engine compartment. The top of the vertical firewall shall be sealed to the engine compartment top panel with a fire resistant seal.

3.12 Propulsion Subsystem. -

3.12.1 General Description and Components. - Two General Electric X353-5B propulsion systems shall be used. Propulsion systems shall be in accordance with G.E. Specification 112, dated 15 January 1962. A General Electric X376 Pitch Fan shall be installed in the forward fuselage section and shall be in accordance with G.E. specification number 113, dated 1 March 1962.

3.12.1.1 Each gas producer (J-85) shall power one-half of each fan turbine. Engine cross-coupling ducts shall be provided to accommodate single engine power loss. Single engine power loss shall not produce unsymmetric loading between the fans. A tailpipe shroud and ejector system shall be employed to remove cooling air from the engine compartment during conventional flight. Engine-driven fans shall be provided to augment cooling during VTOL flight. Nose fan bleed ducts shall be cooled by ram air inlets which supply air along the ducts, and discharge into the pitch fan inlet duct. Wing fans shall be cooled by forced flow through ram inlets, past the scrolls, and discharged overboard. A thrust spoiler device shall be employed to allow low forward thrust component at high gas producer output, to aid in conversion from conventional to fan powered flight. Cockpit throttles shall be provided to permit individual or collective control of the gas generators. A conventional throttle quadrant shall be provided at the left of the pilot for individual control of gas generator output. A twist grip on the collective lift control shall afford joint regulation of gas producer power.

3.12.1.2 An air impingement starter system shall be provided. Starter ducts shall be routed from each engine, and shall terminate at an external connector installation located in the lower portion of the center fuselage bay. System installation shall provide for individual engine starting. Check valves shall be provided in each engine installation.

3.12.1.3 The aircraft fuel system (see Figure 29) shall consist of a main fuel system and an extended range fuel system. The main system shall consist of a foreward and aft fuel tank having 1600 pounds total capacity. The extended range system shall consist of a foreward belly tank, an aft belly tank, and a dorsal tank located in the aft fuselage section above the engine tailpipes. Total capacity using the extended range system shall be 4800 pounds. Extended range tank weight shall not be included as part of aircraft empty weight, but shall be considered as payload. All fuel tanks shall be provided with fuel vent lines and overboard vent fittings with screens. All tanks shall be provided with fuel sumps containing water drain lines and valves. The main system tanks shall contain cross-feed lines and valves. Extended range system tanks shall be provided with fuel transfer lines and shutoff valves. All fuel tanks, with exception of dorsal tank, shall contain fuel boost pumps with sufficient capacity to maintain fuel system pressures. The dorsal tank shall gravity feed and shall not require a boost pump. Fuel strainers shall be provided in the main system fuel lines between the engines and the fuel tanks. Main system lines shall contain low-pressure warning switches.

3.12.1.3.1 Fuel Management Description will be added later.

3.12.2 Installed Power Plant Performance

3.12.2.1 Installed power plant performance shall be calculated using a General Electric supplied, engine performance computor deck describing the X353-5B propulsion system. Calculated performance shall be based on various engine and flight conditions involving altitudes up to 40,000 feet under ARDC standard day, and ANA hot day conditions. Installation losses involved in the calculations shall be: engine inlet pressure recovery, engine inlet drag, gas producer power extraction, gas producer turbine discharge bleed, conventional-flight exhaust duct loss, and tailpipe cooling ejector loss. Lift fan and pitch fan inlet closure losses, and losses due to cooling air injected into fan inlets. Internal ducting losses and fan losses shall be included as part of the General Electric performance deck.

3.12.2.2 The engine air inlets shall be sized to minimize losses during lift fan operation, and to provide satisfactory performance at high flight speeds. A boundary layer bleed duct approximately 16 inches square shall be located under the inlets, and furnish cooling air for engine installations. Estimated inlet pressure recovery is presented in Figure 30. Estimated external drag increment coefficient is shown in Figure 31. Values given in the above figures have been substantiated by inlet-model wind tunnel tests.

3.12.2.3 Gas producer power extraction losses shall be based on steady-state daylight operation. In the conventional flight mode, 30 horsepower shall be extracted from each engine to accomodate hydraulic drive, cooling fan, and electrical system requirements. In fan flight mode, 46 horsepower shall be extracted from each engine.

3.12.2.4 Engine tailpipes shall be approximately 120 inches long, with 2 bends of 20 degrees located near each end of the tailpipes. Conventional flight exhaust duct loss shall be calculated using methods supplied by General Electric. Estimated loss is presented in Figure 32. Preliminary tailpipe ejector performance shall be based on a boundary layer bleed inlet area at approximately 16 inches, and a conical cooling air ejector. Tailpipe ejector performance is presented in Figures 33 and 34.

3.12.2.5 Pitch fan lift data shall be based on a lift capability of 1300 pounds at 2500 feet, ANA 421 hot day. This capability results in a 10.6 percent turbine discharge bleed factor which is included in all installed lift performance data used in this specification.

3.13 Secondary Power and Distribution Subsystems. -

3.13.1 Electrical Power Generation and Distribution Subsystem. - Electrical power shall be supplied by two engine-driven 28 VDC generators, (See Figure 35). Emergency power shall be supplied by battery. Electrical power conversion shall be accomplished by two 115 V AC, 400 cycle, single phase inverters. Each inverter shall be capable of supplying normal current loads. In event of power loss of one inverter, electrical loads shall be automatically transferred to the other inverter. An external power receptacle shall be provided for ground checkout. Additional description of the aircraft electrical system will be provided later.

3.13.2 Hydraulic Power Generation and Distribution Subsystem. - Two independent hydraulic systems shall be provided, (See Figure 36). Each system shall operate continuously, and be capable of supplying full load requirements in event of pressure loss of one system. Both systems shall use engine-driven pumps. Hydraulic power shall be provided to control actuators through tandem cylinders positioned by servo control and solenoid valves. Pressure transmitters in each system shall supply signals to a dual reading hydraulic pressure gage located in the cockpit. Provisions shall be included for cockpit warning in event of system pressure loss. External ground-test connections shall be provided to facilitate filling and system checkout. Additional description of the aircraft hydraulic system will be provided later.

3.13.2.1 The following control elements shall be hydraulically actuated: wing fan exit louvers; wing fan inlet doors; engine diverter valves; pitch fan controls; main landing gear actuation; nose landing gear actuation; brakes.

3.13.3 Pneumatic Power Generation and Distribution Subsystem. - A gaseous nitrogen (GN_2) system shall be provided (See Figure 37). The system shall provide for emergency landing gear actuation in event of hydraulic system pressure loss. Gaseous nitrogen shall be stored in main landing gear cylinders.

3.14 Utilities and Equipment Subsystems. -

3.14.1 Air Conditioning. - Cockpit cooling and ventilation shall be supplied in the form of fresh ram air. An exhaust fan shall be provided to remove stale air from the cockpit. Provisions shall not be made for air conditioning.

(diagram to be supplied at a later date)

Figure 29 Aircraft Fuel System Schematic

ESTIMATED INLET PRESSURE RECOVERY

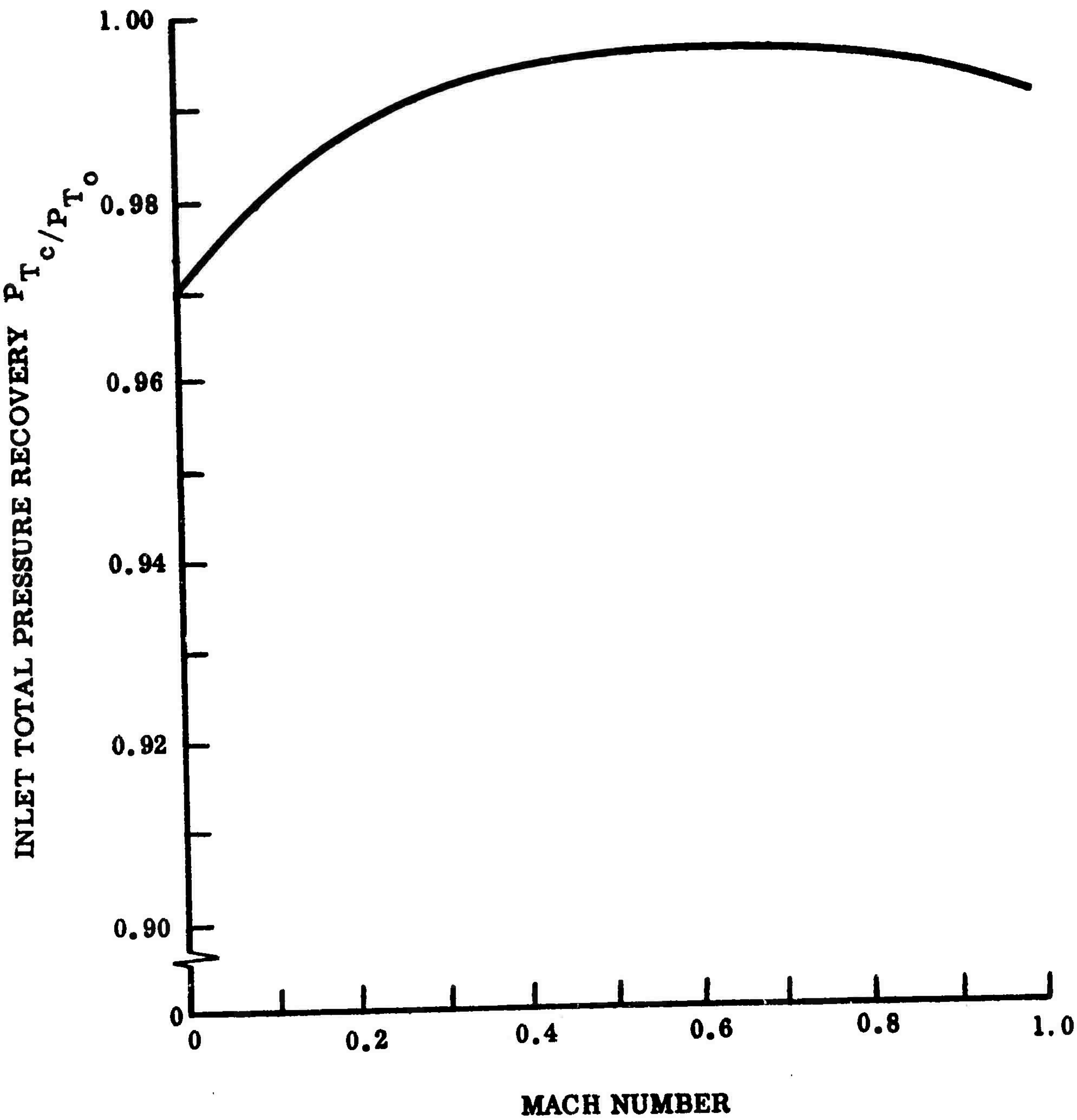


Figure 30 Estimated Inlet Pressure Recovery

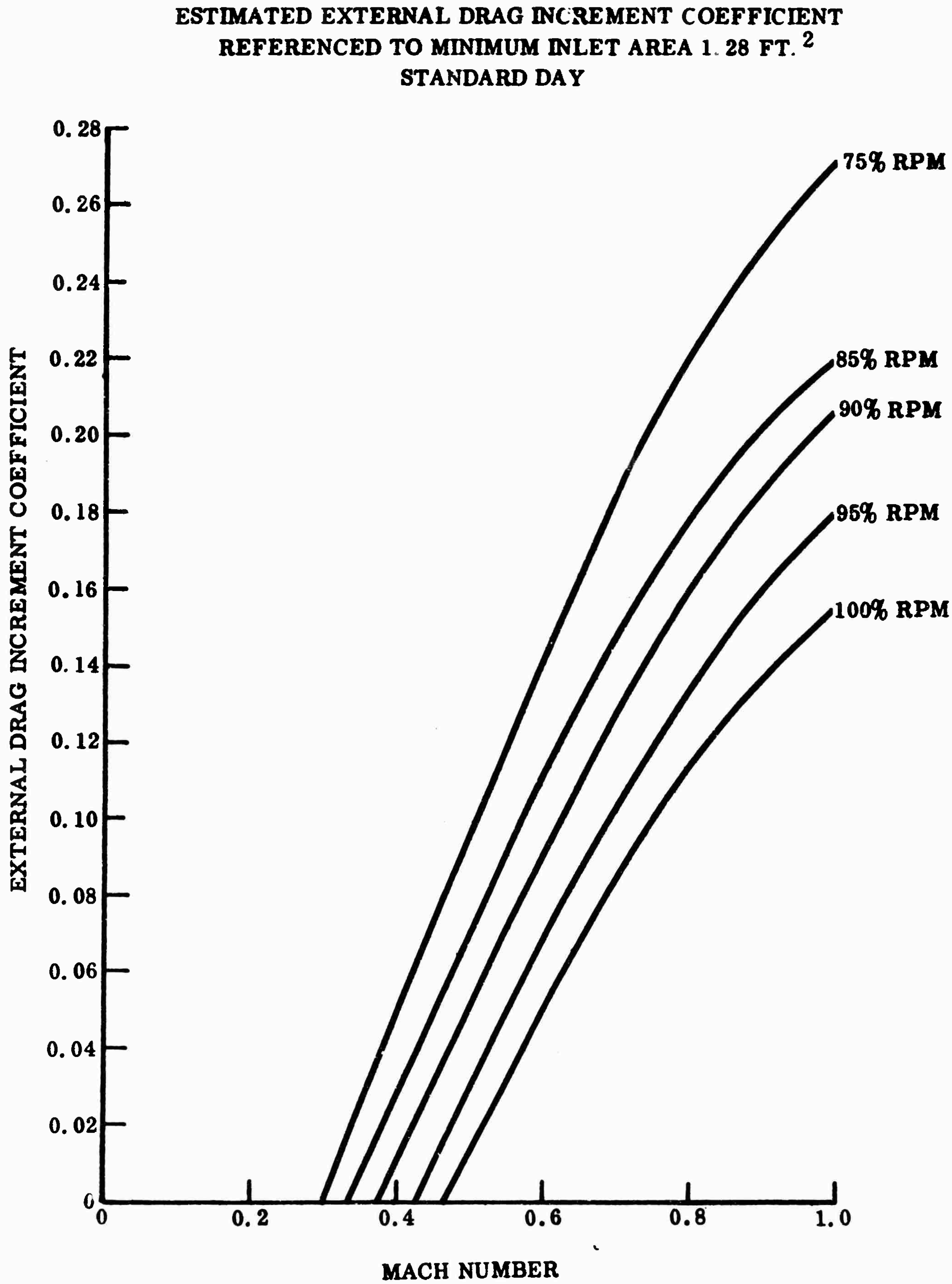


Figure 31 Estimated External Drag Increment Coefficient

ESTIMATED EXHAUST DUCT LOSS
CONVENTIONAL FLIGHT MODE

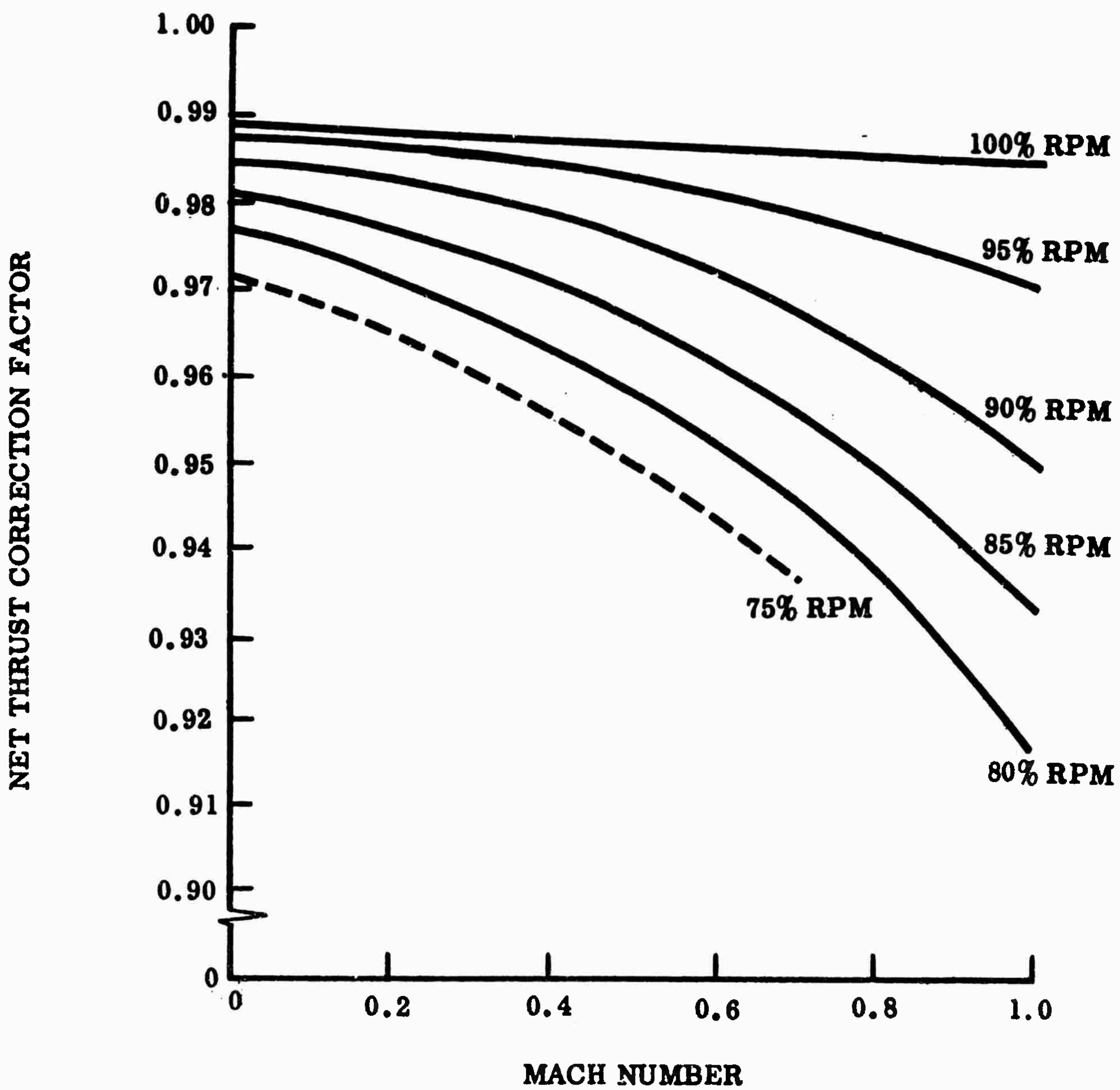


Figure 32 Estimated Exhaust Duct Loss

EJECTOR NET THRUST/PRIMARY NET THRUST VERSUS MACH NUMBER
MILITARY POWER

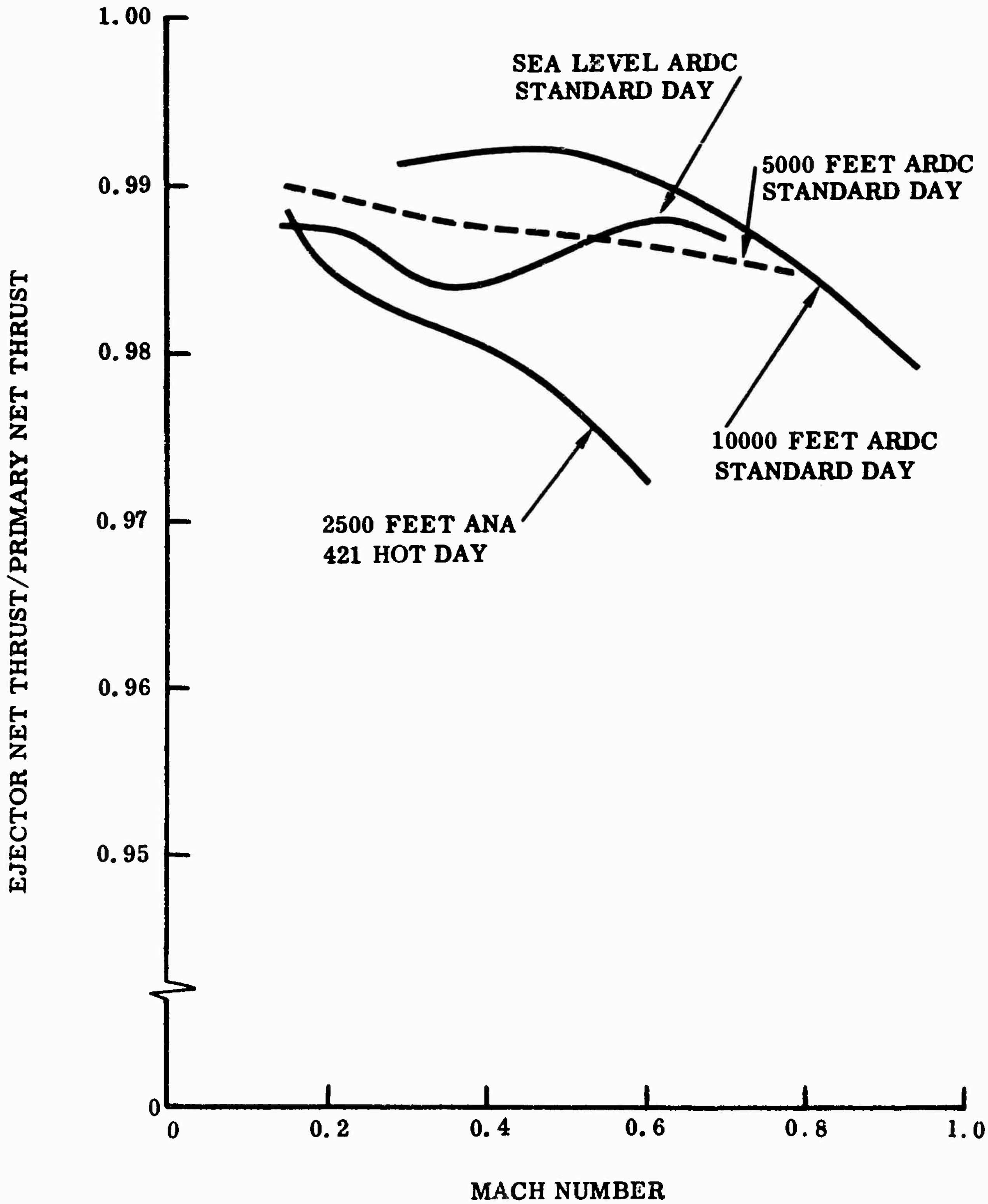


Figure 33 Ejector Net Thrust/Primary Net Thrust Versus Mach Number

COOLING WEIGHT FLOW/GAS GENERATOR WEIGHT FLOW VERSUS MACH NUMBER
MILITARY POWER

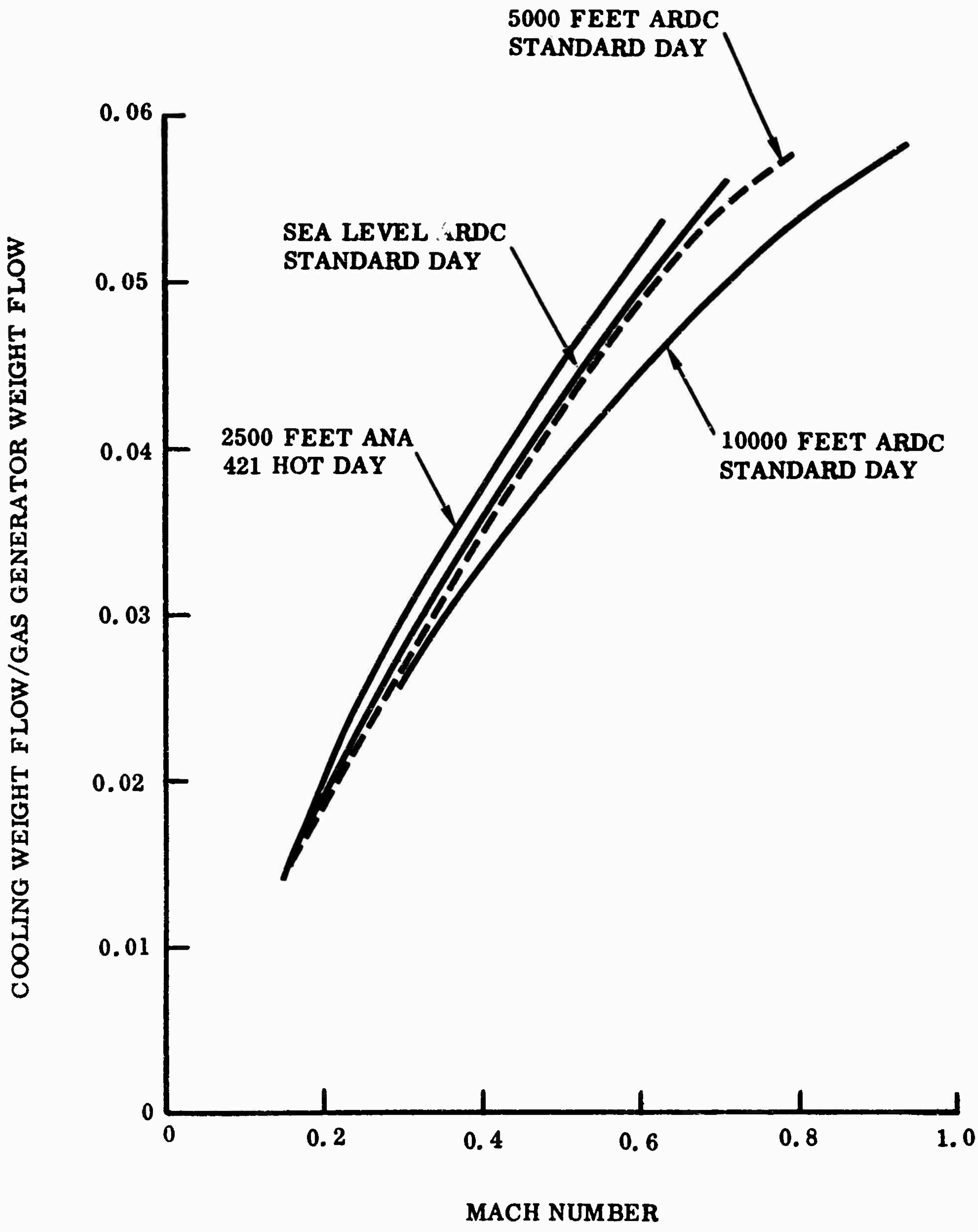


Figure 34 Cooling Weight Flow/Gas Generator Weight Flow Versus Mach Number

(diagram to be supplied at a later date)

Figure 35 Aircraft Electrical System Schematic

(diagram to be supplied at a later date)

Figure 36 Aircraft Hydraulic System Schematic

(diagram to be supplied at a later date)

Figure 37 Aircraft Emergency Pneumatic System Schematic

3.14.2 Anti-Icing. - Anti-icing shall not be provided for the wing or tail surfaces. Engine ice prevention shall be provided at the inlet ducts.

3.14.3 De-Fogging. - Circulating fresh air shall be provided for windshield de-fogging.

3.14.4 Moisture Control. - Moisture control shall not be provided.

3.14.5 Pressurization. - Cockpit pressurization shall not be provided.

3.14.6 Fire Radiation Hazard Detection. -- Fire detection and indicating systems shall be installed in the engine compartment, and hot gas duct areas, in accordance with specification MIL-D-7006A(ASG). Additional description of the fire detection and indicating systems will be provided later.

3.14.7 Fire Prevention. - Fire prevention features shall be provided in the form of engine firewalls, isolation areas, and heat shields.

3.14.8 Fire Protection. - Fire extinguishing systems shall be provided in the engine compartment.

3.15 Mission and Air Traffic Control Subsystems. -

3.15.1 Communications Subsystem. - A VHF communications system shall be provided.

3.15.2 Navigation Subsystem. - Not applicable.

3.15.3 Identification Subsystem. - Not applicable.

3.16 Reconnaissance Subsystems. - Not applicable.

3.17 Fire-Power Control Subsystems. - Not applicable.

3.18 Armament Subsystems. - Not applicable.

3.19 Cargo and Transport Subsystems. - Not applicable.

3.20 Countering Subsystems. - Not applicable.

3.21 Ground Handling and Servicing Provisions. -

3.21.1 Towing Provisions. - Provisions shall be made to forward tow the aircraft by the nose wheel. Nose wheel design shall accommodate towing speeds of 20 MPH maximum over smooth hard surfaces, and 3 MPH maximum over soft surfaces.

3.21.2 Jacking Provisions. - Provisions shall be included for jacking of the wings and fuselage. Jack points shall be provided on each main landing gear.

3.21.3 Mooring and Holdback Provisions. - Tie-down lugs shall be provided to accommodate aircraft mooring. Removable holdback fittings for engine thrust tests shall be provided.

3.21.4 Hoisting Provisions. - Provisions shall be included for hoisting the entire aircraft, and major subassemblies.

3.21.5 Handling Provisions. - Dollies shall be provided by the prime contractor for handling and maintenance of engine, and, wing and nose fan assemblies.

3.21.6 Covers. - Covers shall be provided for environmental protection of the cockpit canopy, engine inlets and exits, pitot mast, and exposed openings.

3.21.7 Hydraulic Test Equipment. - Hydraulic test equipment shall be provided for test and operation of hydraulic controls, and individual hydraulic components.

3.21.8 Miscellaneous Servicing Equipment. - Miscellaneous servicing equipment for ground handling and checkout shall be provided as required.

3.22 Aerial Resupply Subsystems. - Not applicable.

3.23 Air Rescue Subsystems. - Not applicable.

3.24 Range Extension Subsystems. - (Information to be added later).

3.25 Air Weather Subsystems. - Not applicable.

3.26 Preflight Readiness Checkout Provisions. - Provisions shall be incorporated to permit thorough preflight readiness checkout of the aircraft.

4. QUALITY ASSURANCE PROVISIONS. -

4.1 Unless otherwise specified by the procuring activity, inspection methods and tests shall be performed using specification MIL-Q-9858 as a guide. Specific aircraft subsystems shall be inspected as outlined by applicable specifications.

5. PREPARATION FOR DELIVERY. -

5.1 The aircraft shall be prepared for delivery to Edwards Air Force Base, California, for flight test.

6. NOTES. -

6.1 Intended Use. - This preliminary specification is intended for use as the contract document which describes the aircraft supplied under terms of the contract. The characteristics and performance of this specification shall be considered as design objectives, and the Ryan Aeronautical Company shall exert best efforts to achieve said design objectives.

APPENDIX I-A

Contractor Furnished Aircraft Equipment, Subcontractor Installed

Item	Quantity	Description	Identification	Unit Weight
1	2	Propulsion System, General Electric	X353-5B	
2	1	Pitch Fan System, General Electric	X376	
3	2*	Ejection Seat, North American	Zero Altitude, Zero-Speed LW-2	

* 1 ejection seat shown in weights statement paragraph 3.1.3

APPENDIX I-B

Contractor Furnished Aircraft Equipment, Contractor Installed

Not applicable.

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APPENDIX I-C

Subcontractor Furnished Aircraft Equipment, Subcontractor Installed*

Propulsion System

Item	Quantity	Description	Identification
1	2	Pump, Fuel Boost	
2	4	Filter, Fuel	
3	4	Tank, Fuel	
4	4	Cap, Fuel Tank	
5	2	Pump, Oil	
6	2	Cooler, Oil	
7	2	Cap, Oil Tank	
8	1	Valve, Fuel Proportioning	

*List to be finalized at final specification submission.

APPENDIX I-C (Continued)

Subcontractor Furnished Aircraft Equipment, Subcontractor Installed*

Flight Control System

Item	Quantity	Description	Identification
1	1	Control Stick	
2	2	Rudder pedals	
3	1	Collective Control Lever	

*List to be finalized at final specification submission.

APPENDIX I-C (Continued)

Subcontractor Furnished Aircraft Equipment, Subcontractor Installed*

Landing Gear

Item	Quantity	Description	Identification
1	2	Wheels, main landing gear	
2	2	Tires, main landing gear	
3	2	Brakes, main landing gear	
4	2	Struts, main landing gear	
5	1	Wheel, nose landing gear	
6	1	Tire, nose landing gear	
7	1	Strut, nose landing gear	

*List to be finalized at final specification submission

APPENDIX I-C (Continued)

Subcontractor Furnished Aircraft Equipment, Subcontractor Installed*

Instruments

Item	Quantity	Description	Identification
1	1	Accelerometer	
2	1	Airspeed-Mach meter	
3	1	Attitude Indicator	
4	1	Rate-of-Climb Indicator	
5	1	Stall Warning	
6	1	Turn & Bank Indicator	
7	1	Standby Compass	
8	1	Elevator & Flap Position Indicator	
10	1	Fuel Quantity Indicator	
11	1	Fuel Flow Indicator (Dual)	
12	1	Oil Pressure - Temperature Indicator (Dual)	
13	1	Engine Tachometer (Dual)	
14	1	Hydraulic Pressure Indicator, (Dual)	
15	1	Pitot Head	
16	2	Tachometer	
17	2	Volt-Ammeter	
18		Indicator Lights	
19		Master Caution Panel	

*List to be finalized at final specification submission.

APPENDIX I-C (Continued)

Subcontractor Furnished Aircraft Equipment, Subcontractor Installed*

Electrical System

Item	Quantity	Description	Identification
1	1	VHF Radio-Transmitter	
2	2	Generator 165 AMP	
3	2	Generator Control Unit	
4	1	Battery	
5	2	Relay, 200 AMP	
6	2	Relay, 50 AMP	
7	4	Relay, 25 AMP	
8	5	Relay, 10 AMP	
9	10	Relay, 5 AMP	
10	2	Ammeter Shunt	
11	2	Inverter	
12	2	Relay Voltage Sensor	
13	2	Tachometer-Generator	
14	2	Oil Pressure Transmitter	
15	2	Hydraulic Pressure Transmitter	
16	1	Transformer, 115V - 26V	
17		Ignition Unit	
18		Fuel Quantity Sensor	
19		Fire Extinguisher	
20		Fire Detector	
21		Fan Vent	
22		Switches	
23		Circuit Breakers	

*List to be finalized at final specification submission.

APPENDIX I-C (Continued)

Subcontractor Furnished Aircraft Equipment, Subcontractor Installed*

Hydraulic System

Item	Quantity	Description	Identification
1	5	Tandem Hydraulic Cylinder with Integral Electrohydraulic Servo Valve	
2	2	Pump - Variable Displacement Engine Driven	
3	2	Accumulator 3000 PSI	
4	2	Reservoir - Self-Pressurizing	
5	4	Pressure Relief Valve	
6	2	Pressure Switch	
7	12	Filter - 10 Micron	
8	4	Shuttle Valve	
9	8	Wing Fan Door Actuators	
10	1	Horizontal Stabilizer Actuator	
11	8	4-way, Solenoid Operated Selector Valve	
12	2	Pressure Transmitter	
13	2	Heat Exchanger, Oil-to-Air	

*List to be finalized at final specification submission.

APPENDIX I-D

Subcontractor Furnished Ground Servicing Equipment

Item	Quantity	Description	Identification
1.	2	Cockpit Canopy Cover	
2.	4	Engine Inlet Cover	
3.	4	Engine Exhaust Cover	
4.	2	Pitot Mast Cover	
5.	2	Cockpit Ladder	
6.	1	Thrust Stand Adapter	
7.	1	Hoist Sling	
8.	1	Towbar	
9.	1	Jack Pad Set	
10.	2	Tie Down Adapter Set	
11.	1	Hydraulic Check-Out Stand (as required)	
12.	1	Electrical Check-Out Stand (as required)	
13.	4	Compressor Interstage Bleed Covers	
14.		Landing Gear Down Locks	
15.		Surface Locks	
16.		Tire Pressurization Equipment	
17.		Landing Gear Wheel Clocks	
18.		Lubrication Equipment	

APPENDIX I-E

Contractor Furnished Ground Servicing Equipment

Lift Fan

Item	Quantity	Description	Identification
1	1	Rotor Lift Fixture Vertical Centerline	
2	1	Rotor Buildup Stand and Turnover Dolly	
3	1	Rotor Platform	
4	1	Grommet Pusher	
5	1	Pin Removing Tool	
6	1	Tool for Installing Retainer Pin	
7	1	Ball Bearing Puller, Inner Race	
8	1	Rotor Bearing Guide	
9	1	Spanner Wrench	
10	1	Inner Race Pusher	
11	1	Roller Bearing Puller, Inner Race	
12	1	Front Frame Lift Fixture and Slings	
13	1	Front Frame Buildup and Transport Dolly	
14	1	Front Frame Bearing Puller, Ball Bearing, Outer Race	
15	1	Front Frame Bearing Puller, Roller Bearing, Outer Race	
16	1	Front Frame Shipping Container	
17	1	Rear Frame Exit Louver Protractor (requires aircraft reference for level)	
18	1	Lift Fan Buildup Dolly	

APPENDIX I-E (Continued)

Contractor Furnished Ground Servicing Equipment

Diverter Valve

Item	Quantity	Description	Identification
1	1	Diverter Valve Lift Fixture	
2	1	J85/Diverter Valve Lift Fixture	
3	1	J85/Diverter Valve Support and Assembly Stand	
4	1	J85 Support Stand	

Pitch Fan

Item	Quantity	Description	Identification
1	1	Pitch Fan Assembly Buildup and Turnover Stand	
2	1	Pitch Fan Rotor Buildup Platform	
3	1	Shaft Puller	
4	1	Bearing Puller, Outer Race	
5	1	Bearing Puller, Inner Race	
6		Shaft Line-up Pins	
7	1	Pitch Fan Rotor Lift Fixture	